

"Government in the Sunshine Act" (5 U.S.C. 552b), notice is hereby given that at 4:05 p.m. on Thursday, February 16, 1984, the Board of Directors of the Federal Deposit Insurance Corporation met in closed session, by telephone conference call, to consider the following matter:

Recommendation regarding the liquidation of a bank's assets acquired by the Corporation in its capacity as receiver, liquidator, or liquidating agent of those assets:

Case No. 45,949-L City & County Bank of Knox County, Knoxville, Tennessee

In calling the meeting, the Board determined, on motion of Chairman William M. Isaac, seconded by Director Irvine H. Sprague (Appointive), concurred in by Mr. Doyle L. Arnold, acting in the place and stead of Director C. T. Conover (Comptroller of the Currency), that Corporation business required its consideration of the matter on less than seven days' notice to the public; that no earlier notice of the meeting was practicable; that the public interest did not require consideration of the matter in a meeting open to public observation; and that the matter could be considered in a closed meeting pursuant to subsections (c)(4), (c)(6), (c)(9)(B), and (c)(10) of the "Government in the Sunshine Act" (5 U.S.C. 552b(c)(4), (c)(6), (c)(9)(B), and (c)(10)).

Dated: February 17, 1984.

Federal Deposit Insurance Corporation,
Hoyle L. Robinson,
Executive Secretary.

[FR Doc. 84-4916 Filed 2-21-84; 12:57 pm]

BILLING CODE 6714-01-M

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FEDERAL ELECTION COMMISSION

DATE AND TIME: Tuesday, February 28, 1984 at 10:00 a.m.

PLACE: 1325 K Street, NW., Washington, D.C.

STATUS: This meeting will be closed to the public.

ITEMS TO BE DISCUSSED: Compliance. Litigation. Audits. Personnel.

PERSON TO CONTACT FOR INFORMATION:

Mr. Fred Eiland, Information Officer,
Telephone: 202-423-4065.

Marjorie W. Emmons,

Secretary of the Commission.

[FR Doc. 84-4880 Filed 2-21-84; 10:40 am]

BILLING CODE 6715-01-M

7

FEDERAL MINE SAFETY AND HEALTH REVIEW COMMISSION

TIME AND DATE: 10:00 a.m., Wednesday, February 29, 1984

PLACE: Room 1730 K Street, N.W., Washington, D.C.

STATUS: Open

MATTERS TO BE CONSIDERED: The Commission will hear oral argument on the following:

1. James Eldridge v. Sunfire Coal Company, Docket No. KENT 82-41-D. (Issues include whether the Commission's Administrative Law Judge erred in concluding that the operator's discharge of the miner violated section 105(c) of the Mine Act, and whether the judge made an appropriate remedial award.)

TIME AND DATE: Immediately following oral argument, February 29, 1984.

STATUS: Closed (Pursuant to 5 U.S.C. 552b(c) (10)).

MATTERS TO BE CONSIDERED: The Commission will consider and act on the above docket.

CONTACT PERSON FOR MORE

INFORMATION: Jean Ellen, Agenda Clerk
(202) 653-5632

Jean H. Ellen,

Agenda Clerk.

[FR Doc. 84-4960 Filed 2-21-84; 3:12 pm]

BILLING CODE 6735-01-M

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SECURITIES AND EXCHANGE COMMISSION

"FEDERAL REGISTER" CITATION OF PREVIOUS ANNOUNCEMENTS: (To be published)

STATUS: Closed Meeting.

PLACE: 450 Fifth Street, N.W., Washington, D.C.

DATE PREVIOUSLY ANNOUNCED: Tuesday, February 7, 1984.

CHANGE IN THE MEETING: Additional item.

The following item was considered at a closed meeting scheduled for Tuesday, February 14, 1984, at 9:30 a.m.

Settlement of injunctive action. Chairman Shad and Commissioners Treadway and Cox determined that Commission business required the above change and that no earlier notice thereof was possible.

At times changes in Commission priorities require alterations in the scheduling of meeting items. For further information and to ascertain what, if any, matters have been added, deleted or postponed, please contact: Bruce Kohn at (202) 272-3195.

George A. Fitzsimmons,

Secretary.

February 17, 1984.

[FR Doc. 84-4910 Filed 2-21-84; 12:43 am]

BILLING CODE 8010-01-M

9

TENNESSEE VALLEY AUTHORITY (MEETING NO. 1326)

TIME AND DATE: 2:00 p.m. (EST), Monday, February 27, 1984

PLACE: TVA West Tower Auditorium, 400 West Summit Hill Drive, Knoxville, Tennessee

STATUS: Open

Agenda Items

Approval of minutes from meeting on February 1, 1984.

Discussion Item

1. TVA skills development program.

Action Items

B—Purchase Awards

- B1. Invitation C3-675205—Indefinite quantity term contract for No. 2 diesel fuel oil for various TVA locations.
- B2. Requisition 71—Term coal for Kingston and John Sevier steam plants.
- B3. Supplement to Requisition 86—Coal for Johnsonville and Widows Creek steam plants.
- B4. Negotiation 62-925567-2—Low-pressure turbine parts and repair services for Browns Ferry Nuclear Plant.
- B5. Amendment to contract 71C62-54114-2 with Babcock and Wilcox for nuclear steam supply system for the Bellefonte Nuclear Plant.
- B6. Conversion of TVA's uranium enrichment contracts to the new Department of Energy utility services contract.
- B7. Proposal J3-693515—Lease of CDC Hardware and Services.

C—Power Items

- C1. Proposed form agreement amending agreements covering TVA's Load Management Commercial and Industrial Heat and Cool Storage Demonstration Project to provide for direct control of energy storage systems.

D—Personnel Items

- D1. Revised salary structure and pay rates for salary Schedule SG—Public Safety Service employees.

E—Real Property Transactions

- E1. Grant of permanent easement to the State of Alabama for the construction, operation, and maintenance of a highway affecting approximately 7.4 acres of Guntersville Reservoir land in Jackson County, Alabama—Tract No. XTGR-135H.
- E2. Grant of permanent easement to Clay County, North Carolina, for the construction, operation, and maintenance of a public road affecting approximately 3.3 acres of Chatuge Reservoir land in Clay County, North Carolina—Tract No. XTCHR-27H.
- E3. Grant of permanent easement to the Town of Dandridge, Tennessee, for a sewerline affecting approximately 0.09 acre of Douglas Reservoir land in Jefferson County, Tennessee—Tract No. XTDR-29S.

F—Unclassified

- F1. Amendment to TVA Code II—Claims and Litigations.
- F2. Retention of net power proceeds and nonpower proceeds pursuant to section 26 of the TVA Act.
- F3. Contract between TVA and the Greater Kingsport Area Chamber of Commerce providing for assistance under TVA's economic impact mitigation program (TV-63503A).
- F4. Supplement to contract between TVA and Middle Tennessee Industrial Development Association providing for additional funds under TVA's economic impact mitigation program (TV-61517A).
- F5. Supplement to memorandum of understanding with the U.S. Army Corps of Engineers covering arrangements for participation by TVA in the development of a recreation trail system at Big South Fork National River and Recreational Area Project (TV-58724A).
- F6. Long-term timber sale contract with Sullivan Timber Company at Land Between The Lakes (TV-63285A).

CONTACT PERSON FOR MORE

INFORMATION: Craven H. Crowell, Jr., Director of Information, or a member of his staff can respond to requests for information about this meeting. Call (615) 632-8000, Knoxville, Tennessee. Information is also available at TVA's Washington Office (202) 245-0101.

Dated: February 17, 1984.

John G. Stewart,

Assistant General Manager.

[FR Doc. 84-4934 Filed 2-21-84; 2:16 pm]

BILLING CODE 8120-01-M

10

UNIFORMED SERVICES UNIVERSITY OF THE HEALTH SCIENCES

Meeting.

AGENCY HOLDING THE MEETING:

Uniformed Services University of the Health Sciences.

TIME AND DATE: 8:00 a.m., February 27, 1984.

PLACE: Uniformed Services University of the Health Sciences, Room D3-001, 4301 Jones Bridge Road, Bethesda, Maryland 20814.

STATUS: Part of the meeting will be open to the public and part will be closed to the public.

MATTERS TO BE CONSIDERED:

8:00 Meeting—Board of Regents.

(1) Approval of Minutes—November 14, 1983—Revision of Action Taken; (2) Faculty Appointments; (3) Report—Admission; (4) Report—Associate Dean for Operations: (a) Budget, (b) Amount of Grant Monies/Department; (5) Report—President, USUHS: (a) Graduate Education: (1) Self-Study, (2) Military Medical/Surgical Clinical Congress; (b) Certification of Graduate Student; (c) Hebert School of Medicine: (1) U.S. Medicine Article, (2) Dedication Date; (d) Part I, National Board of Medical Examiners Results; (e) Elective Program Analysis; (f) Graduate Medical Education Comparative Study; (g) Defense Officer Personnel Management Act; (h) Jackson Foundation; (i) Board of Regents: (1) Retreat, (2) Travel, (3) Future Meeting Dates; (j) USUHS Awards Program; (k) Information Items; (6) Comments by the Chairman of the Board; (7) Faculty Research Presentations; (8) Awards Presentation.

Closed to the Public: (9) Faculty Salaries New Business.

SCHEDULED MEETINGS: May 19, 1984.

CONTACT PERSON FOR MORE

INFORMATION: Donald L. Hagengruber, Executive Secretary of the Board of Regents, 202/295-3049.

GENERAL COUNSEL CERTIFICATION: The General Counsel, in accordance with section 3(f)(1) of the Government in the Sunshine Act, 5 U.S.C. 552b(f)(1) and the Board of Regents' rules issued under that Act, 32 CFR 242a.6(g), hereby certifies that portion of the Board of Regents' meeting of February 27, 1984, at which the Board will consider the salary of two individuals, pursuant to 10 U.S.C. 2113(f), may properly be closed to the public on the basis of the exemption set forth in the Board of Regents' rules at 32 CFR 242a.4(b) and (f).

Merel P. Glaubiger,

General Counsel.

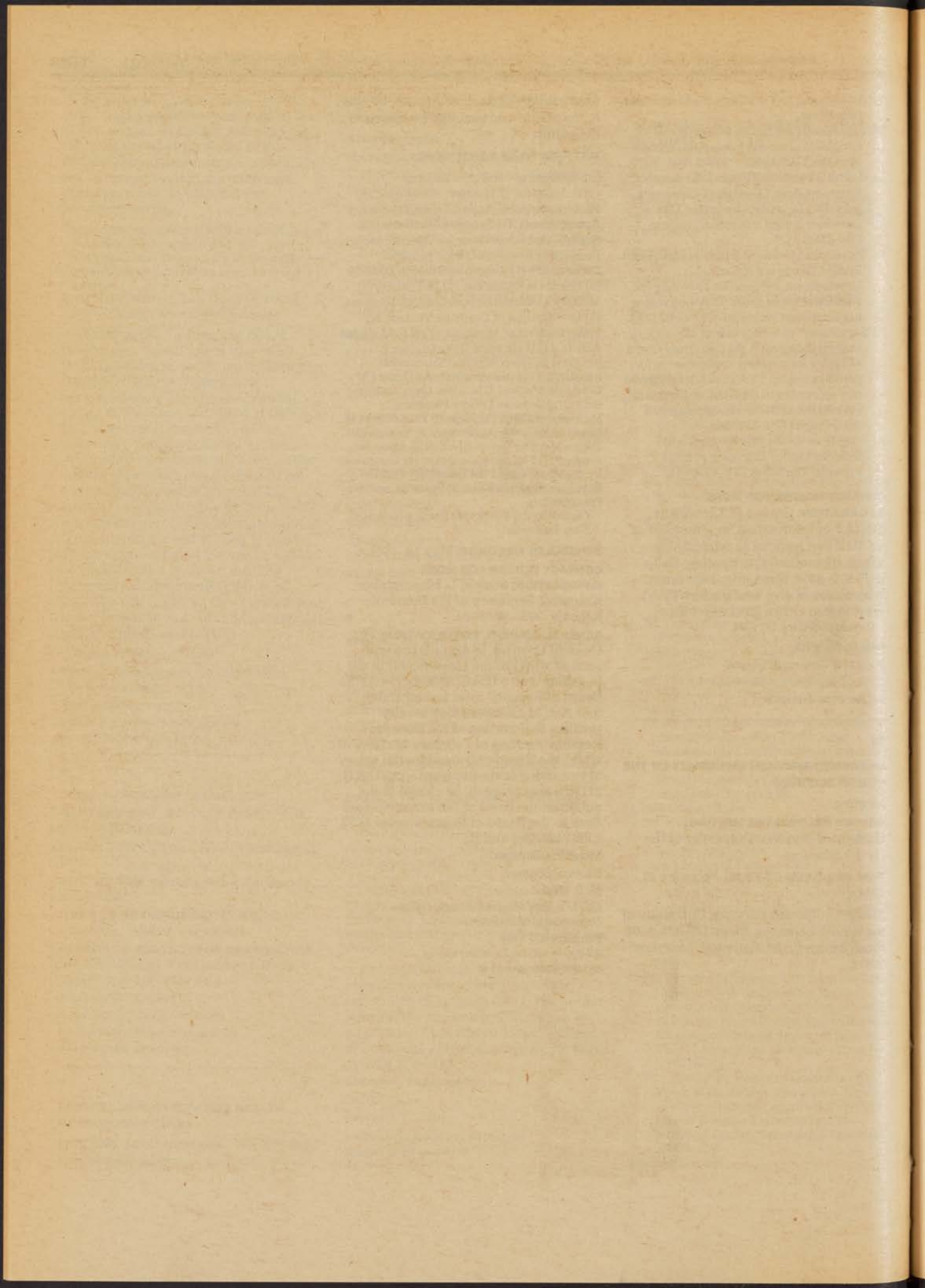
M. S. Healy,

*OSD Federal Register Liason Officer,
Department of Defense.*

February 17, 1984.

[FR Doc. 84-4891 Filed 2-21-84; 11:54 am]

BILLING CODE 3810-01-M



14 CFR Parts 23, 25, 27, 29, and 33

Thursday
February 23, 1984

Part II

**Department of
Transportation**

Federal Aviation Administration

14 CFR Parts 23, 25, 27, 29, and 33

**Aircraft Engine Regulatory Review
Program; Aircraft Engine and Related
Powerplant Installation Amendments;
Final Rule**

DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration

14 CFR Parts 23, 25, 27, 29, and 33

[Docket No. 16919; Amdt. Nos. 23-29; 25-57; 27-20; 29-22; and 33-10]

Aircraft Engine Regulatory Review Program; Aircraft Engine and Related Powerplant Installation Amendments

AGENCY: Federal Aviation Administration (FAA), DOT.

ACTION: Final rule.

SUMMARY: This amendment updates the airworthiness standards applicable to the type certification of aircraft engines and of aircraft with respect to engine installations. The changes implement the President's Regulatory Reform Program by simplifying a number of technical requirements, by eliminating unnecessary rules where appropriate, and by removing administrative burdens on regulated persons and the FAA through amendment of regulations from which exemptions have been granted. The regulations update and modernize technical requirements to reflect engineering advances in the state-of-the-art and take into account accumulated service experience and recommendations of the National Transportation Safety Board (NTSB).

EFFECTIVE DATE: March 26, 1984.

FOR FURTHER INFORMATION CONTACT: George F. Mulcahy, Engine and Propeller Standards Staff, ANE-110, Aircraft Certification Division, New England Region, Federal Aviation Administration, 12 New England Executive Park, Burlington, Massachusetts 01803; telephone: (617) 273-7330.

SUPPLEMENTARY INFORMATION:

Background

Following recodification in 1965, the first significant revision to the Code of Federal Regulations (CFR) Title 14, Part 33—Airworthiness Standards: Aircraft Engines, was made late in 1974 by Amendment 33-6. The amendment sought to accommodate the increasing complexity of airframes and engines and their interfaces and the further impact of supersonic flight. During ensuing years, as the industry became even more complex and specialized, the need for clarification and elimination of redundancies in test and design requirements became evident.

Responding to these needs, the FAA in mid-1977 announced an Aircraft Engine Regulatory Review Program, solicited rule change proposals from the aviation and general community, and

held a week-long Regulatory Review Conference in January 1978, attended by over 100 industry and public representatives.

Based on information received during the review program and conference, the Administrator issued Notice of Proposed Rulemaking (NPRM) 80-21, Aircraft Engine Regulatory Review Program; Aircraft Engine and Related Powerplant Installation Proposals (45 FR 76872; November 20, 1980), which proposed to upgrade the airworthiness standards applicable to the type certification of aircraft engines and of aircraft with respect to engine installations. Comments on the proposals were invited until February 18, 1981.

Interested persons now have been given an opportunity to participate in the making of these amendments, and due consideration has been given to all matters presented. The proposals and comments are discussed below. Substantive changes and changes of an editorial and clarifying nature have been made to the proposed rules based upon relevant comments received and further review within the FAA. Except for minor editorial and clarifying changes and the substantive changes discussed below, these amendments and the reasons for them are the same as those proposed and explained in Notice 80-21.

Discussion of comments

The following discussion summarizes the comments received from the public, from industry, and from foreign authorities. Proposals are numbered as in Notice 80-21.

Proposal 1. This amendment clarifies § 23.901(d), which calls for a determination that installation effects do not cause any deterioration of powerplant rain ingestion tolerance as demonstrated by the engine in compliance with the engine certification standards of § 33.77.

One commenter advises that it is not clear whether a specific determination for deterioration of powerplant rain ingestion tolerance is required for the intake-engine combination or whether the test of Part 33 would suffice. The intent of the proposed rule is to ensure that installation effects do not result in any deterioration of powerplant rain ingestion tolerance. This requires a separate determination for the engine installation, other than that required by 14 CFR Part 33.

A commenter recommends that flight idle be included in the evaluation of operation in rainfall conditions. The FAA agrees that the regulation, as proposed, does not specify operating conditions for the rain ingestion investigation and the operating

conditions of takeoff and flight idle are added to the rule as adopted.

One commenter recommends that the specified liquid water content be compared to engine induction airflow rate. It is the intent of the regulation to proportion the ingested liquid water content in relation to the induction airflow, and this recommendation would afford clarification. Therefore, the proposed rule is revised by adding the phrase "4 percent of engine airflow by weight."

A commenter recommends that the requirement for 3 minutes of operation at flight idle in rain be deleted. The FAA disagrees. Satisfactory operation of an engine for 3 minutes at flight idle in the rain conditions specified will provide assurance that it will satisfactorily operate throughout the rain conditions likely to occur in service. The 3-minute time period is therefore retained.

A commenter recommends that the regulations be clarified by removal of words such as "safe" and "hazardous," which are considered ambiguous. The FAA believes that these words have a common interpretation in aviation and that § 23.901 is sufficiently clear without further change.

Proposal 2. This amendment to § 23.903(a) permit the installation of an engine approved under standards other than those of 14 CFR Part 33, such as Part 13 of the Civil Air Regulations (CAR) or Part 21 of the Federal Aviation Regulations (FAR). In addition, provision is made for approving installation of a type certificated engine on the basis of satisfactory service experience if the engine has not specifically complied with § 33.77. Proposed § 23.903(b) also will require that precautions be taken in the design of aircraft to protect vital components from the effects of uncontained rotor failures and engine fires.

Four commenters request that § 23.903(a) be revised to include reference to § 21.29(a)(1)(ii), which pertains to certification of import products. To be eligible for installation in a U.S. type certificated aircraft, an engine must have a U.S. type certificate. Engines imported from a foreign country type certificated in accordance with § 21.29 are covered by the amended wording of § 23.903(a), and no further action is required.

One commenter advises that under the proposed wording of § 23.903(a)(2)(i) existing engines could be disqualified each time § 33.77 was amended, a condition which would be unreasonable. The intent of this rule change is to ensure an acceptable level of safety for all engine installations with relation to

foreign object ingestion (FOI). A certificated engine which has shown compliance with an approved standard and has had a satisfactory FOI service history when installed in a similar aircraft location will continue to be eligible for installation in an aircraft under paragraph (a)(2)(ii). Therefore, no further change to the proposed rule is necessary.

A commenter advises that the proposed wording of § 23.903(a)(2)(ii) would deny an applicant the right to apply service experience from a particular aircraft engine installation to justify certification at a different location on the aircraft. The commenter states that there is no proof that some installation locations have a higher frequency of ingestion than others, wing mounted versus aft mounted, for example, nor has frequency of ingestion been found to be related to engine capability to withstand ingestion of objects. FAA policy is to certify engines independently of installation location and/or number of engines per aircraft. Nevertheless, when satisfactory service experience is used as a basis of approval of an engine installation, the location of the engine during the time this experience was accumulated must be considered to determine whether the new installation is more or less subject to FOI, and whether similar results may be expected in the proposed installation. This policy is adequately expressed in the proposal, and no further change is necessary.

One commenter recommends clarifying § 23.903(a) with a third qualifying condition: that the engine be shown to comply with § 33.77 in effect at the time of engine type certification. The FAA has determined that addition of a third alternative might result in an unacceptable level of safety under FOI conditions. Section 33.77 in effect October 1, 1974, or thereafter is specifically referenced to preclude this eventuality.

A commenter recommends that § 23.903(b) be revised to specify the areas needing protection from rotor burst, such as fuel systems, flight control systems, and occupied areas of the fuselage. The FAA notes that areas which may be critical in one aircraft with respect to the effects of rotor burst may not be critical in another. Accordingly, it is left to the designer to determine which areas must be protected and how to protect them, and the proposed general language provides such latitude. However, the FAA will evaluate each design for compatibility with the intent of this regulation.

One commenter objects to the wording of the proposed regulation and

does not consider turbine engine rotor failure or casing burn-through a problem for small aircraft engines. Turbine engine rotor failure has been reported in small turbine engines, although problems have not been noted in recent years. As long as the potential for failure continues to exist, however, the problem should remain under consideration. Measures taken to protect aircraft from effects of rotor burst also are expected to resist burn-through. Proposed § 23.903(b) as drafted ensures protection appropriate to the risk involved and is therefore adopted as proposed.

Proposal 3. This amendment revises existing § 23.905 to allow installation of a propeller approved under standards other than 14 CFR Part 35. Commenters agree with this rule change. Therefore, except for deletion of the qualifier "approved," which is not applicable in reference to a type certificate, the rule is adopted as proposed.

Proposal 4. This amendment to § 23.975(b) requires that each fuel injection engine employing vapor return provisions, as well as carburetor engines having such provisions, have a separate vent line to return vapor to the vapor space in one of the fuel tanks. Four commenters recommend that the proposed regulation be revised to require fuel vapor to be returned to the fuel tank but not specifically to the vapor space, provided the return line location is carefully selected. However, carburetors with vapor elimination features currently in service have a very low return fuel pressure with which to overcome flow resistance in the line, so that the static fuel pressure head at a particular location might be sufficient to prevent proper venting of the carburetor. Also, discharging the vapor return line into the fuel tank at a location near the fuel tank outlet could result in vapors being reintroduced to the engine with subsequent loss of power. The proposed amendment is changed in accordance with these comments to specify that the vapor be returned to the top of one of the fuel tanks.

One commenter recommends that it would be preferable to return the vapor to the selected tank (the tank being used). The FAA agrees but considers this requirement to be a substantial change which would add significant complexity and cost to the fuel system of airplanes certificated under Part 23 without a commensurate increase in safety.

Proposal 5. This amendment to § 23.994 redefines the required protection against fuel spillage in terms of that occurring after wheels-up landing on a paved runway. One commenter questions whether any amount of fuel

spillage should be allowed during a wheels-up landing. Another suggests that a specified amount of spillage would be more appropriate. The FAA agrees that it would be desirable to prevent any fuel spillage during a wheels-up landing on any type of landing surface, but it also recognizes that release of minute quantities of fuel would not be likely to present a fire hazard and that complete avoidance of fuel spillage or approval of a specific amount would be very difficult. Therefore, the regulation is adopted as proposed.

Proposal 6. This amendment adds a new § 23.995(g) specifying that fuel tank selector valves must take a separate and distinct action to place the selector in the "OFF" position and that the selector must not pass through the "OFF" position when changing from one tank to another.

One commenter recommends that the proposed wording be changed to read: "The valve shall be designed so that it is not necessary to move the selector through 'OFF' position when switching tanks." The FAA believes that the proposed phrasing is more positive, and the rule is adopted in this form. This change is in accordance with National Transportation Safety Board (NTSB) Safety Recommendation No. A-79-72.

Proposal 7. Part of the proposed amendment to § 23.997 was intended to make it clear that an aircraft manufacturer need not duplicate equipment or tests of fuel strainers or filters if they were provided and approved as part of a certificated engine and if they also meet the requirements of this subpart. The proposed wording, however, inadvertently exempted such provided equipment from the latter requirement. The intended relief is already provided as an option to aircraft and engine manufacturers under the current rule. Therefore, the portion of the proposed rule exempting engine-supplied devices is withdrawn.

The rule also corrects terminology and relieves design requirements for mounting fuel strainers or filters.

Commenters question the meaning of the words "fuel metering device," recommend that filtration standards be included for the filters/strainers, and recommend that the fuel filter be placed ahead of any other fuel system component subject to contamination. The FAA has determined that a fuel metering device is commonly understood to be one which regulates or "meters" fuel flow and that fuel filtration standards should not be included in the regulation but covered by policy material. The rule, in

conjunction with § 23.977, assures that filters and strainers are properly located to prevent contaminants from blocking components other than pumps and controls. In some installations the suggested locations would in fact be unfeasible.

Proposals 8 and 9. The proposed changes to §§ 23.1013 and 23.1015, which deal with oil tanks approved and provided as part of an engine, are withdrawn for the same reasons given in Proposal 7 for withdrawing the portion of the wording exempting engine-supplied devices.

Also, a commenter questions whether an equivalent provision originally proposed for Part 25 applies to engines certificated to the standards of Part 33 before Amendment 33-6 and suggests that this be clarified. The commenter asserts that the oil tanks may be unsafe if not substantiated under Amendment 33-6. The concern expressed by the commenter has been taken into account by withdrawing the proposal.

Proposal 10. This change to § 23.1019 corrects terminology and is intended to relieve the airplane manufacturer from duplicating compliance with oil strainer/filter design requirements if they are provided and approved as part of the engine to be installed. The proposed rule, except for that portion which corrects terminology, is withdrawn for the reasons given in Proposal 7.

One commenter recommends that oil filtration standards be included in the regulations. The FAA believes that filtration standards would be more appropriately covered by an advisory circular or equivalent advisory information.

Proposal 11. This proposal amends § 23.1021 to permit the use of multiple oil system drains, if necessary, to provide more efficient drainage. All commenters agree with the change, and the regulation is adopted as proposed.

Proposal 12. The proposed change of § 23.1093 brings the ground idle induction system icing test conditions into conformance with Appendix C of 14 CFR Part 25 and permits periodic operation at increased power or thrust higher than ground idle as an ice protection measure.

One commenter questions whether "momentary operation at takeoff power" is adequate. Another commenter questions whether allowing engine runup on an icy taxiway would be a safe condition. The FAA agrees that the second comment may have merit under certain conditions. However, the relaxatory nature of this part of the regulation need not be denied applications where safety is not

compromised. On icy runways, the decision to use momentary power or thrust to remove induction ice would remain with the flightcrew. The first comment addresses part of the current regulation not raised under Notice 80-21 and therefore is outside the scope of the proposed change.

One commenter recommends a referenced military specification, MIL-E-5007D, which would be a somewhat more severe requirement (25 °F, mean effective drop diameter 30 microns, and .4 grams per cubic meter liquid water content). Actual meteorological data, as presented at the Aircraft Engine Regulatory Review Conference, does not support this severe requirement. It is considered that the revised test criteria take into consideration actual ground icing conditions, including an adequate margin of safety, and that compliance with MIL-E-5007D is not warranted. Therefore, § 23.1093 is adopted as proposed.

Proposal 13. This proposed change would add a new § 23.1143(e) to: (1) state engine control requirements not only for antidetonant injection (ADI) systems, but for other fluid injection systems (other than fuel) as well; (2) make it clear that any fluid injection system and its controls provided and approved as part of the engine need not be duplicated by the aircraft manufacturer; and (3) specify a separate control for fluid injection pumps.

Five commenters object to proposed § 23.1143(e)(1) on the grounds that it restricts design of fluid control to one of a number of satisfactory types. It is their view that fluid injection requirements are influenced by other factors which may not relate to the amount of power produced by an engine in service. In some cases, the engine installations have fluid systems that do not vary the fluid flow with power. Fluid is injected in a fixed amount, and power is varied by the engine fuel control via the power lever. The proposed paragraph is rephrased to permit more flexibility in design.

One commenter requests that the regulations be clarified so that separate control for fluid injection pumps is required regardless of whether or not the injection system is approved as part of the engine. Another suggests deletion of this paragraph as some current systems do not use pumps. The FAA agrees with the commenters, and the proposed regulation is revised accordingly.

The portion of the proposed rule exempting engine-supplied devices from the requirements of this section is withdrawn for the reason given for § 23.997.

Proposal 14. This amendment revises § 23.1163(a) to make it clear that it is the ultimate responsibility of the aircraft manufacturer who installs an engine to assure proper sealing of engine oil lubricated accessories.

Three commenters request clarification of paragraph (a)(3) to define what is to be sealed. The FAA concurs that the intent is unclear and proposed paragraph (a)(3) is changed to define the extent of sealing.

Proposal 15. The amendment to § 23.1183 would raise the limiting capacity of reciprocating engine oil sumps from 20 to 25 quarts before fireproofing or shielding is required. Also, the regulation exempts components, as well as lines and fittings that have been approved as part of the engine, from these requirements. These changes remove unjustified engine design limitations and afford increased range capabilities.

One commenter recommends that the 20-quart capacity limit required by paragraph (a) be retained. The proposal is seen as an arbitrary accommodation of a particular application for type certification, but the commenter does not supply specific information or data to support this claim. A search of FAA records has not disclosed such an application.

Neither service with 20-quart capacity oil systems nor any other evidence has shown that there would be any compromise of safety associated with a sump capacity of 25 quarts of oil as opposed to 20 quarts in the case of a powerplant fire. The amendment is adopted as proposed.

Proposal 16. The amendments to § 23.1189(a)(1) and (b)(2) clarify the requirements for shutoff means for flammable fluids in multiengine aircraft and for turbine engine oil systems.

One commenter recommends that this rule be cross-referenced to 14 CFR Part 33. Another commenter suggests addition of the word "installation" to paragraph (a)(1) for the sake of clarity.

The FAA does not consider a cross reference to Part 33 necessary since the emphasis of this section is upon the aircraft manufacturers' responsibility to ensure a fireproof engine installation. Adding the word "installation," however, will provide additional clarification. The proposed regulation is adopted with this change.

Other comments contain proposals for Part 23 which were not on the agenda of the Aircraft Engine Regulatory Review Program. These include the addition of a new § 23.907 concerning acceptable propeller stress levels and addition of a rule requiring that positive pressure be

maintained within fuel tanks to prevent vapor formation. These recommendations are outside the scope of the proposed amendment and are not addressed by this rulemaking.

Proposal 17. This revision of § 25.33(a)(2) corrects and updates an obsolete reference to the rules and does not constitute a substantive change. No unfavorable comments were received, and the proposal is adopted.

Proposal 18. No unfavorable comments were received with respect to revising § 25.697(a) to correct reference to obsolete rules. The proposal is therefore adopted without change.

Proposal 19. For a discussion of comments on the proposed amendment to § 25.903(a), see the proposal for § 23.903(a).

Proposal 20. This proposal revises § 25.905(a) to allow installation of a propeller type certificated under the procedures of CAR Part 14 or § 21.29 of the FAR, as well as Part 35 of the FAR. No unfavorable comments were received with respect to revising § 25.905(a). Therefore, except for deletion of the qualifier "approved," which is not applicable in reference to a type certificate, the rule is adopted as proposed.

Proposal 21. Six commenters object to and recommend deleting the proposed change to § 25.939(b). The consensus is that determination of surge and stall margins in quantitative terms is beyond the current state-of-the-art and that adequate investigation of engine stall, surge, and flameout characteristics is currently covered by the requirements of § 25.939(a). Therefore, the proposed change to § 25.939(b) is withdrawn. The comparable proposal to amend § 33.65 also is withdrawn.

Proposal 22. This amendment to § 25.961 restores test conditions for hot weather fuel system operation previously deleted.

One commenter recommends deleting proposed paragraph (a)(4)(i)(D), arguing that the center of gravity is not relevant to hot fuel tests. This reference to the most unfavorable center of gravity was continued over from the deleted § 25.65(a)(4) as one of the conditions for demonstrating all engine climb in cruising configuration. The FAA agrees that unfavorable center of gravity is not relevant to the hot fuel test, and paragraph (a)(4)(i)(D) of the proposed change is deleted. The proposed amendment is adopted as revised.

Proposal 23. For a discussion of comments on and disposition of the proposed amendment to § 25.994, see the proposal for § 23.994.

Proposal 24. For a discussion of comments on and disposition of the

proposed amendment to § 25.997, see the proposal for § 23.997.

Proposal 25. The proposed revision of § 25.1001 removes the distinction between fuel jettisoning systems for reciprocating and turbine engine-powered airplanes, deletes obsolete sections, and corrects references to climb performance sections. Other changes are editorial in nature, eliminate redundancies, and clarify the text.

No unfavorable comments on the proposed change of § 25.1001 were received. However, two commenters recommend rephrasing the requirement of paragraph (b)(3) to specify that fuel or fumes do not enter any part of the airplane in sufficient quantity to constitute a fire or explosion hazard, maintaining that not all fuel or fumes necessarily constitute a fire or explosion hazard. A third commenter recommends revising paragraph (b) to rectify a condition in which the intended reduction in airplane weight cannot be achieved when jettisoning is initiated with the fuel quantity and distribution associated with takeoff at maximum zero fuel weight (that is, for short range with high cabin load).

Fuel or fumes should not be allowed to reenter any part of the airplane during an emergency condition such as jettisoning. It would be difficult to establish the amount of fuel or fumes that does constitute a hazard. Regarding the wording in paragraph (b), the FAA agrees that the comment has merit; however, it is outside the scope of the proposed change. The rule is adopted as proposed.

Proposals 26 and 27. No unfavorable comments were received in response to the proposed changes to §§ 25.1013 and 25.1015. However, the portion of the proposals dealing with oil tanks provided and approved as part of an engine is withdrawn for the reasons stated for § 23.997. For a discussion of reciprocating engine oil sump capacity in relation to fireproofing requirements in § 25.1013, see the proposal for § 23.1183.

Proposal 28. No adverse comments were received on the proposal to amend § 25.1019, and the change is adopted as proposed. For a discussion of this change, see the proposal for § 23.1019.

Proposal 29. No adverse comments were received on the proposal for § 25.1021, and it is adopted as proposed (See the proposal for § 23.1021).

Proposal 30. This amendment to § 25.1045(d) corrects references to performance requirements which have become obsolete. In addition, a commenter would delete the cooling test configuration center of gravity

requirement as irrelevant. Another commenter suggests the following rewording: "... the most unfavorable center of gravity position at which the airplane can be flown safely."

Reference to the most unfavorable center of gravity was carried over from deleted § 25.67, which governed demonstration of one engine inoperative climb. Section 23.121(c) is the new reference, and it has no requirement for center of gravity position. In any case, the airplane must be flown within the airplane limitations.

The FAA agrees that for this cooling test the effect of center of gravity position is negligible and does not affect the outcome. The proposed amendment is revised and adopted.

Proposal 31. This amendment to § 25.1091(e) requires the foreign object ingestion criteria of § 33.77 to be applied to vulnerable portions of induction systems.

Comments received were generally favorable. Two commenters recommend, however, that additional wording be included to specify the air induction system parts or components to be considered under this rule.

The FAA believes that the proposed change adequately states the performance objectives of the airplane air induction system and the criteria to be applied. Listing specific components to be protected would ignore possible future developments. The change to § 25.1091(a) therefore is adopted as proposed.

Proposal 32. For a discussion of comments on and disposition of the proposed amendment to § 25.1093(b)(2), see the proposal for § 23.1093(b)(2).

Proposal 33. For a discussion of comments on and disposition of the proposed amendment to § 25.1143(d), see the proposal for § 23.1143(e).

Proposal 34. For a discussion of comments on and disposition of the proposed amendment to § 25.1163(a), see the proposal for § 23.1163(a).

Proposal 35. For a discussion of comments on and disposition of the proposed amendment to § 25.1183(b)(1), see the proposal for § 23.1183(b)(1).

Proposal 36. For a discussion of comments on and disposition of the proposed amendments to § 25.1189(a) (1) and (2), see the proposals for § 23.1189(a)(1) and (b)(2).

Proposal 37. This amendment would have deleted § 25.1305(d)(3), which calls for a rotor system unbalance indicator in each turbojet installation.

One commenter disagrees, stating that the requirement should be retained and arguing that foregoing the monitoring of airborne vibration would be a

retrograde step. The commenter claims that well developed systems have shown more than adequate reliability and are considered capable of giving advance warning of impending failures.

Service experience has not shown that installation and use of airborne vibration monitor (AVM) systems are universally beneficial, as they are not totally effective in providing advance warning of all hazardous engine failure modes. However, recent experience, since this amendment was proposed, has demonstrated the potential of an AVM to provide a safety improvement as discussed by the first commenter. Therefore, the proposal to delete § 25.1305(d)(3) is withdrawn pending further study.

Proposal 38. No unfavorable comments were received regarding the proposed change to § 25.1323(b)(2), which deletes an obsolete reference to § 25.59, and it is adopted without change.

Nonsubstantive changes are made to §§ 25.1359 and 25.1521 which were not included in the Regulatory Review Conference Agenda or in Notice 80-21. These amendments correct typographical errors and references.

Proposals 2 and 19 modify §§ 23.903(a) and 25.903(a), respectively, to require an "approved type certificate" for each engine installed, rather than a type certificate issued under Part 33 only. The discussion presented for the proposal for § 23.903(a) also applies to §§ 27.903(a) and 29.903(a). Therefore, substantively identical changes to these sections are adopted.

A commenter suggests that in connection with the revised wording, turbine engines installed in rotorcraft should be required to comply with the foreign object ingestion requirements of § 33.77, which is now the case for engines type certificated after October 1, 1974. For engines for which application for type certificate was made before that date, this suggestion constitutes a substantive change beyond the scope of this rulemaking and is not adopted.

Proposal 39. For a discussion and disposition of the proposed amendment to § 27.997, see also the proposal for § 23.997.

One commenter questions the rationale behind deleting the phrase "and the mesh" and claims that without this phrase only filter capacity is addressed by the rule. The term "mesh" is not applicable to filters or filter elements. However, fuel filtration requirements, including mesh, particle size, and density, if not satisfied by the engine manufacturer, will be prescribed in the instruction manual for installing and operating the engine (§ 33.5).

Therefore, in this case, compliance would be assured by reference to § 33.5 in § 27.901(c)(1) and the requirements in § 27.977 (§§ 29.901(b)(1)(i) and 29.977 for Part 29).

Proposals 40, 41, 42 and 43. For discussion and disposition of the proposed amendments to §§ 27.1013, 27.1015, 27.1019, and 27.1021, see the proposals for §§ 23.997, 23.1019, and 23.1021.

Proposals 44 and 54. These proposals would delete §§ 27.1093(b)(2) and 29.1093(b)(2), which are the current requirements for demonstrating satisfactory powerplant operation when exposed to atmospheric icing during ground operating conditions. The basis for deletion is the contention that engine induction system icing during ground idle operation has not been a significant problem with rotorcraft, assuming they are not required to queue up for takeoff as are airplanes. Subsequent FAA review of rotorcraft utilization discloses that extended ground operation of rotorcraft during icing conditions, although infrequent, must be expected. The proposals to delete §§ 27.1093(b)(2) and 29.1093(b)(2) therefore are withdrawn and the sections are reworded as in §§ 23.1093(b)(2) and 25.1093(b)(2).

For further discussions on this amendment, see Proposal 75 for § 33.68 and Proposal 12 for § 23.1093.

Proposals 45 and 55. These amendments add new §§ 27.1143(d) and 29.1143 (d) and (e) specifying that fluid injection (other than fuel) controls be in the throttle controls and eliminating duplicate certification requirements, as in §§ 23.1143 and 25.1143. However, the term "throttles" is a misnomer for modern turbine engines installed in rotorcraft. Changes needed to rectify the terminology would be beyond the scope of this review. The proposals to amend §§ 27.1143 and 29.1143 are withdrawn and will be referred to the Rotorcraft Regulatory Review Program for consideration.

Proposals 46 and 56. For a discussion and disposition of the proposed amendments to §§ 27.1163(a) and 29.1163(a), see the proposal for § 23.1163(a).

Proposals 47 and 57. These amendments to §§ 27.1183 and 29.1183 establish a new capacity limit of 25 quarts instead of 20 quarts for reciprocating engine integral oil sumps before requiring the sumps to be fireproof or have fireproof shielding. For a discussion of comments on and disposition of the proposals, see the proposal for § 23.1183.

Proposals 48 and 58. For a discussion and disposition of the proposed

amendments to §§ 27.1189 and 29.1189, see the proposal for § 23.1189.

Proposals 49, 50, 51, 52, and 53. For discussion and disposition of the proposed amendments to §§ 29.997, 29.1013, 29.1015, 29.1019, and 29.1021, see the corresponding proposals for Part 23.

Proposal 59. This amendment to § 33.7 revises the engine operating limit requirements for fuel and oil temperature and pressure, overhaul, and windmilling r.p.m.

All comments support adoption of this proposal. Additionally, two commenters propose changing Appendix A of Part 33 to be compatible with deleting the word "overhaul," as proposed in the amendments to §§ 33.7(c)(17) and 33.90. However, reference to the term "overhaul" is still appropriate to many turbine and basically all reciprocating engines. While the FAA believes there is merit in considering a restructuring of Appendix A, it goes beyond the scope of the Notice 80-21. Accordingly, the amendment is adopted as proposed.

Proposal 60. This amendment to § 33.14 revises and clarifies the rules establishing engine low-cycle fatigue limits.

One commenter suggests that the definition of start-stop cycle fails to account for reduced power takeoff and therefore should be modified to read "... accelerating to takeoff thrust levels ..." rather than "... accelerating to maximum rated power or thrust. ..." Reduced power takeoff is an operational procedure determined by prevailing factors such as aircraft weight, runway length, and density altitude. The FAA believes the fatigue life used for certification should be the minimum service life based on maximum ratings since the engine operational characteristics will vary for each aircraft installation. Both cyclic and hourly life credits for reduced stress levels experienced by some discs during reduced power takeoff can be adjusted by the use of approved methodology. One engine manufacturer has done so by creating "disc life factors" to apply to those cycles or hours of operation under required conditions. The established life thus has a certain conservative bias, as it is based on maximum ratings.

Another commenter objects to the proposed wording of this section because it eliminates the distinction between maximum predicted and initial service life and suggests that a part could continue in service up to its maximum predicted life without undergoing the specified sampling program. The commenter suggests that some fixed percentage of the predicted life be established as the initial service

life. The FAA does not agree that a lack of distinction will exist between initial and predicted life. The predicted life of a disc is evaluated by the applicant using approved low-cycle fatigue methodology involving factors such as material properties, engine thermodynamics, etc., which when used in the analysis result in a confidence level for the predicted life. Based on this confidence level, the service life may vary from one-third to three-fourths or more of the predicted life. To require the initial service life to be a fixed proportion of the predicted life, i.e., 50 percent for instance, would place an undue burden on the applicant with no commensurate safety benefit. Any program to increase the initial service life must include sampling or inspection procedures. For these reasons, the rule, except for some editorial changes, is adopted as proposed.

Proposal 61. No unfavorable comment was received on the proposal to amend § 33.15(b) by deleting the phrase "or Technical Standard Orders," given erroneously as a standard for engine materials, and the proposal is adopted without change.

Proposal 62. This amendment to § 33.17 increases the limiting oil capacity for reciprocating engine integral oil sumps from 20 to 25 quarts before fireproofing is required.

One commenter takes exception to the wording of § 33.17(a), which implies that any structural failure or overheating in turbine engines would represent a hazardous condition. The same language has been carried under deleted § 33.17(f) and has presented no problems in interpretation.

A commenter recommends that the present 20-quart oil limit be retained, implying that it was established by fire testing. The FAA has no records which show that the 20-quart limit was derived from fire test data. Its original intent was to exclude the integral oil tanks of small reciprocating engines from fireproofing requirements, and it was based on years of satisfactory service experience. The FAA does not believe that raising this limit to 25 quarts as proposed will violate the original intent (see also the proposal for § 23.1183). Since the 25-quart limit was proposed over 4 years ago, the FAA has received no evidence that would indicate this change would compromise safety. Therefore, the amendment is adopted as proposed.

Proposal 63. This amendment to § 33.19(a) requires an applicant for an engine type certificate to define the trajectories of rotor blade fragments exiting outside compressor or turbine rotor cases.

Two commenters object to the last word of § 33.19(a) in that it is unduly restrictive. The commenters state that the requirement that fragment energy levels and trajectories be "defined" can be interpreted to mean precisely defined by tests, whereas in practice they may be determined by engine tests, component tests, and/or analysis. The FAA disagrees that use of the word "defined" is unduly restrictive. It is the FAA's intent that the boundary condition for possible fragments be set and therefore defined. The method used may include engine tests or other means acceptable to the Administrator.

Another commenter suggests that a corresponding change be made to § 33.5 to provide for the location of the data on fragment energy levels and trajectories. However, a change to § 33.5 is not required since the actual location of this data will be referenced on the engine data sheet.

Another commenter suggests a clarification of the rule is required to specify that only where fragments leave the engine through the inlet or turbine exhaust should the energy and trajectories be defined. The FAA believes this clarification is unnecessary. The first portion of the current rule requires containment of damage from blade failures. The new sentence would require definition of the boundary conditions for debris generated by the blade failure and ejected by the engine. It is this possible secondary damage due to debris exiting the inlet, fan, or core exhaust that is pertinent. Accordingly, the proposal is adopted without change.

Proposal 64. This revision of § 33.23 refines definitions and load limits for engine mounting attachments and structure.

Several commenters suggest changing § 33.23(b) to make the wording similar to the aircraft primary structural requirements of §§ 23.305 (a) and (b) and 25.305 (a) and (b). It is suggested that "permanent deformation" in § 33.23(b)(1) be changed to "detrimental permanent deformation." This change would recognize the slight deformations associated with structural hysteresis which do not adversely affect the structure.

It is further suggested that any deformation at limit load which interferes with engine operation should not be permitted, although § 33.23 does not so state, and that the § 25.305, 3-second criterion for demonstration of ultimate load is also appropriate for § 33.23(b)(2); otherwise, the rule could be interpreted to require the structure to withstand ultimate load for an indefinite period of time.

The FAA believes that the primary structural requirements of § 25.305 are appropriate where a variety of designs serving the many structural needs of an aircraft must be evaluated under a single rule. Engine mounting attachment structure represents a much narrower range of design for which the additional provisions of § 25.305 are not needed. Current practice and service experience support this opinion. Therefore, the wording "permanent deformation" is retained.

One commenter would also specify that the engine mounting attachments and structure withstand repeated application of normal loads; that is, there should be fatigue substantiation of critical structural components. Although not currently required, engine mounting attachments and structures are in fact being confirmed under repetitive loading. Adopting this requirement would, however, add regulatory demands beyond those of the proposal. The question of requiring substantiation of mounting attachments and structures under cyclic loads will be considered for future rulemaking action.

One commenter suggests inserting the word "engine" in § 33.23 (a) and (b) to modify "structure" and thus avoid implying that aircraft structure is meant. The FAA agrees, and the proposal is adopted with the wording changed accordingly.

Proposal 65. No unfavorable comment was received on the proposal to amend § 33.25 to delete an unnecessary sentence relating to load requirements already specified in § 33.49(a) and § 33.87(a)(6) for reciprocating and turbine engines, respectively. The amendment permits a minute amount of oil leakage from the engine interior and assigns ultimate responsibility for engine/accessory drive sealing to the aircraft manufacturer. Accordingly, the amendment is adopted as proposed.

Proposal 66. This amendment to § 33.27 revises overspeed test conditions and strength requirements for turbine, compressor, and turbosupercharger rotors and extends these criteria to fan rotors.

Two commenters object to the proposed wording of the posttest acceptability criteria in the last sentence, stating that it is unnecessarily loose and subject to varied interpretation. The FAA disagrees. The intent of the test is to ensure that compressor and turbine rotors have sufficient structural strength to provide reliability and safety during an inservice overspeed situation. The acceptability criterion is that parts show no evidence of incipient failure or distortion which

could cause hazards. Such evidence will differ for each engine type design, and a determination must be made for each case. Although the wording of the current rule is revised, it continues to state that for each type design a proven acceptable condition must be met and demonstrated.

Two commenters recommend that § 33.27(c)(2) (v) and (vi) need not apply if the failure events described are considered improbable. The FAA disagrees. Service experience shows that most severe engine failures, including those caused by disc and shaft failures, would have been judged improbable beforehand. Attempts to apply probability to this rule would not be in the interest of airworthiness.

Two commenters request that maximum permissible r.p.m. be defined as the highest steady state r.p.m. at which an engine shaft can rotate in service. The FAA disagrees. If an engine has a transient rotor speed limitation higher than the steady state limitation, maximum permissible r.p.m. would be the maximum transient speed limit.

Another commenter suggests rearranging § 33.27(c)(2) for clarification and allowing rotor discs with sections thinner than type design to be used to produce equivalent stresses at lower r.p.m. The FAA does not believe that the proposed rearrangement of paragraph (c)(2) would significantly clarify the requirements of the section. While the use of thinned rotor discs as test articles may be justified under certain circumstances, the practice should not be considered typical or normal. The conditions under which the expedient might be acceptable must be evaluated on an individual basis and a determination of equivalency made. Accordingly, the amendment is adopted as proposed.

Proposal 67. This amendment proposes to delete § 33.29(b), which requires that each turbojet engine be provided with a connection for a rotor system unbalance indicator.

A commenter objects to deletion of the requirement for a connection for rotor system unbalance indication. The commenter states that a well-developed system has more than adequate reliability and has capability of giving advance warning of failures which could lead to hazardous events. Two commenters agree to the deletion of the requirement for rotor system unbalance indication. However, one of the commenters adds that airborne vibration monitoring (AVM) could be applicable to some engines and that in cases where reliable AVM systems have been developed, credit could be claimed for the AVM system in showing

compliance with various FAR Part 33 (and Part 25) requirements as part of the basic engine type design. Recent experience has demonstrated that in some instances AVM can provide a safety improvement as discussed by the first commenter. Therefore, the requirement is being retained in Part 33 to provide an engine connection for AVM. Retention of the requirement does not impose a significant burden on the engine manufacturer. Accordingly, the proposal to delete § 33.29(b) is withdrawn.

Proposal 68. This amendment adds requirements for fluid injection (other than fuel) system controls under a new § 33.35(e).

A commenter suggests the proposal be changed to read: "the flow of the injected fluid is adequately controlled," and that paragraph (e)(2) be deleted. The commenter explains there exist systems which inject fluid at a fixed rate independent of power lever position. The commenter adds that some systems do not use pumps but utilize engine bleed air for pressurization and control it manually or automatically with power lever or throttle motion. The FAA agrees with the commenter, and the section is revised accordingly.

Proposal 69. This amendment to § 33.43 removes the requirement to comply with established shaft endurance stress limits when operating an engine with one cylinder not firing.

The single commenter concurs with the intent of this proposal but requests that shaft critical speeds for the cylinder-out condition be included in the operating instructions. The FAA considers that testing done under this section will provide safe operating information, including critical speeds, which must appear in the engine operating instructions in accordance with § 33.5. The proposed amendment is adopted without change.

Proposal 70. No comments were received on the proposal to correct a typographical error in § 33.49, and it is adopted without change.

Proposal 71. No unfavorable comment was received on the proposal to amend § 33.63 by deleting the word "normal," which tended to unduly restrict the operating range of rotational speeds when considering vibratory force and stress on engine and structure. The proposal is adopted without change.

Proposal 72. This proposed change to § 33.65 is based on a similar proposal deferred from Notice 75-31 (40 FR 29410; July 11, 1975) and was introduced into the NPRM after the Aircraft Engine Regulatory Review conference held in January 1978.

The stated objective of this proposed change is to allow flightcrews to completely avoid surge and stall conditions severe enough to cause engine malfunction or damage.

One commenter agrees with the proposal with no amplifying statements. Another commenter, a rotorcraft manufacturer, expects this proposal would supply urgently needed quantitative operating margins. Considering the installation effects of rotorcraft applications, the FAA does not believe this proposal will alleviate the rotorcraft manufacturers' requirements for in-flight investigation of stall and surge characteristics (§§ 27.939 and 29.939).

The combined comments from the other respondents can be summarized as follows:

- (1) The objective of the proposed change is commendable; however,
 - (2) Technology or state-of-the-art does not allow attainment of the objective as stated;
 - (3) The magnitude of testing, just in terms of variables that would need to be investigated, would be formidable and costly with little or no accompanying increase in safety;
 - (4) The FAA has not established documentation to justify such a rule change;
 - (5) An appropriate advisory circular should be issued and coordinated with industry prior to changes to this regulation;
 - (6) Terms such as "severity of the surge and stall" are ambiguous and unamendable to quantitative testing; and
 - (7) The current regulation adequately provides the desired information.
- At this time, the FAA concurs with the first six items above. It further concurs that item (5) may be the first approach to correcting any FAA disagreement with item (7).

As stated under the "Explanation" of the proposed rule, the current rule is objected to for not being able to define an acceptable or rejectable degree of compliance. After further review, it is concluded that this same objection might apply to the proposed rule. Furthermore, the regulation as proposed will not meet the stated objective. The proposed regulation would still be subject to the interpretive process used to determine compliance during certification. Knowledgeable comments and other information received on this proposal make it doubtful that the objectives can be met at this time.

Considering the above, the FAA is at this time deleting this proposed change.

Proposal 73. This amendment to § 33.66 clarifies standards for bleed air system performance and for indication of the functioning of ice protection systems, if bleed air is used and can be controlled.

There were no dissenting comments. However, one commenter objects to the words "aircraft powerplant" in connection with the ice protection system, as the reader might confuse the engine anti-icing system with the aircraft anti-icing or ice protection system provided for the powerplant. The FAA concurs with the comment to use the word "engine" in place of "aircraft powerplant," and the proposal is modified accordingly.

Proposal 74. This amendment to § 33.67 brings engine fuel system standards into conformity with corresponding sections of the aircraft rules. It also adds new fuel control standards.

Since a large number of comments were received on the various sections of the proposed rule, the following discussion has been subdivided into segments for simplicity of discussion.

Ref § 33.67(a). Although no unfavorable comment was received on the proposal to amend § 33.67 by deleting all but the first sentence of § 33.67(a), the dropping of proposed § 33.67(d) introduces the need to restore, in § 33.67(a), the requirements for proper fuel control system functioning, adjustment, locking, and sealing. Therefore, the proposal is modified by deleting only the last sentence of § 33.67(a).

Ref § 33.67(b). A commenter states the proposed revision should specify that the fuel strainer or filter be installed ahead of the first engine fuel system component which is susceptible to restricted fuel flow due to contaminants. The commenter adds that this would assure that the complete engine fuel system is protected from fuel flow interruption due to contamination.

While there is merit to considering amending § 33.67(b), it goes beyond the scope of the present NPRM. These comments should properly be handled by a future NPRM to allow other interested persons time to submit their views. Therefore, the proposal is adopted without change.

Ref § 33.67(b)(3). No comment was received on the proposal to amend § 33.67(b)(3). Accordingly, the proposal, with respect to § 33.67(b)(3), is adopted without change.

Ref § 33.67(b)(4). A commenter suggested that the last sentence of proposed § 33.67(b)(4) be amended to read: "The applicant must provide evidence. . . ." This is intended to

provide experience or alternative means, other than testing, for showing compliance. The FAA agrees that the word "demonstrate" as used in this paragraph would mean to prove by operation of the device, which was not intended as the only acceptable method of substantiation. Therefore, the proposal is modified accordingly.

Ref § 33.67(b)(4)(ii). A commenter suggests deleting proposed § 33.67(b)(4)(ii) and replacing § 33.67(a) with the sentence: "Each fuel system must be capable of sustained operation throughout its flow and pressure range with fuel initially saturated with water at 80°F and having 0.75 cc of free water per gallon added and cooled to the most critical conditions for icing likely to be encountered in operation." The commenter adds that manufacturers should be allowed to show that the total fuel system is capable of operation under those conditions without establishing any specific design criteria such as use of heaters or additives. The commenter further states that some current successful systems use neither anti-icing additives nor fuel heaters.

Another commenter states that although it may be reasonable to accept that a fuel heater can cope with water saturated fuel, the effectiveness of anti-icing additives should be evaluated.

The commenter suggests that the second sentence of § 33.67(b)(4)(ii) be amended to read: "This requirement may be met by showing the effectiveness of specified approved fuel anti-icing additives or that the fuel system is fitted with a fuel heater which is capable of maintaining the fuel temperature at the fuel strainer or fuel inlet above 32°F (0°C) under the most critical conditions."

The FAA does not agree with the first commenter since the proposed change does not restrict the manufacturer to specific design criteria, but rather provides for recognized equivalent means of compliance.

The FAA substantially agrees with the suggestion of the second commenter which rectifies the objections raised and which editorially corrects the proposed changes. Accordingly, the second sentence of proposed § 33.67(b)(4)(ii) is revised except that the words ". . . which is capable of maintaining. . . ." are further changed to ". . . which maintains. . . ."

Ref § 33.67(b)(5). A commenter strongly supports the substance of the proposed revision to § 33.67(b)(5) to require demonstration of filter capability that is related to fuel contamination ". . . likely to be encountered in service. . . ." Another commenter suggests quantifying the degree of

contamination to provide a consistent unambiguous requirement which can be applied fairly and consistently. Two commenters suggest the proposal be canceled and the present wording be retained since engine control system malfunctions due to fuel contamination are not a service problem.

Proposed § 33.67(b)(5) is clarifying; however, the rule for engine certification should not relate to ambiguous aircraft flight requirements, but rather to the time of continued satisfactory engine operation in the mode of partial filter blockage.

Also, there is merit to the comment relative to quantifying the degree of contamination; but, further research is required before such limits can be established. Accordingly, proposed § 33.67(b)(5) is revised as discussed.

Ref § 33.67(c). Two commenters suggest the proposal be changed to read: "(1) The flow of the injected fluid is adequately controlled," and one of the two commenters further suggests deletion of (2). The commenters explain there exist systems which inject fluid at a fixed rate independent of power lever position. The second commenter adds that some systems do not use pumps but use engine bleed air for pressurization and control it manually or automatically with power lever or throttle motion. A third commenter suggests that the flow of injected fluid must be controlled in relation to the design requirements of the engine since power produced by an engine can be influenced by a number of factors. The FAA agrees with the commenters and has revised the section accordingly.

Ref § 33.67(d). A commenter suggests that the proposal should provide for consideration of electric/electronic components which have a documented satisfactory service history. Two commenters state that it seems unnecessary to apply the proposed rule to other than full-authority control systems with electrical or electronic input.

Ref § 33.67(d)(1). One commenter suggests deletion of this section of the proposed rule on the basis that definition of reliability level would be subjective. Two commenters state that a comparative reliability level should not be imposed, the first since it was never required to hydromechanical units and the second since a comparable hydromechanical control for a given engine type may not exist. One of the commenters suggests that electronic control system reliability should be based on in-flight shutdown rate. The same commenter questions the meaning of ". . . combined level."

Another commenter states that adequacy of the secondary systems in controlling the engine for continued flight can only be determined by evaluation on the specific aircraft in conjunction with minimum crew requirements. It is noted that the requirement for continued safe operation of the installed engine after failure or malfunction is addressed in §§ 23.903, 25.903, and 29.903. However, the FAA agrees that the proposed wording is not completely consistent with engine certification requirements.

Another commenter submits a counterproposal which it is claimed will permit control functions not historically available with hydromechanical controls and will allow dispatch of an airplane with one channel of a dual system inoperative.

Another commenter supports the substance of the proposal and suggests the requirement be extended to other components susceptible to external electromagnetic interferences. The FAA agrees that the rule should be so extended; however, since the suggestion is beyond the scope of this review, the commenter is invited to submit it in proposal form for future consideration.

Ref § 33.67(d)(2). Two commenters suggest revising proposed § 33.67(d)(2) to read "Provide a means to monitor the operational status of each function critical for safe engine operation." Another commenter states it is not clear how monitoring the operational status can assure redundancy. The commenter adds that the designer should be permitted to establish compliance in a manner best suited to his particular design.

Ref § 33.67(d)(3). One commenter suggests that the term "independent power source" be clarified to more clearly state the intent. Two commenters suggest the proposal be revised since it is unnecessary to have an independent power source on the engine where a backup hydromechanical control is used in the event of power supply failure.

Ref § 33.67(d)(4). A commenter states that the proposal is too specific and that the engine manufacturer should be permitted to establish the power supply and environmental condition characteristics, including lightning or other electromagnetic interference, in which the control system will satisfactorily operate.

The scope of comments to § 33.67(d) has been extensive and raised several valid points and suggestions. Due to the extent of these comments, it is believed a major modification to this proposed change is required. Therefore, proposed § 33.67(d) is withdrawn. After

reevaluation, another NPRM will be published, and the public will be given an opportunity to comment.

Proposal 75. The amendment to § 33.68 revises the requirements which govern performance under icing conditions.

A number of commenters support the proposed exemption of rotorcraft from the ground idling icing requirements, basing their justification on the unique characteristics of rotorcraft and rotorcraft operations. Others who wish to include rotorcraft under this rule point out, for instance, that oil rig operations may include lengthy loading cycles in icing conditions with rotors turning.

One commenter points out that wheel-equipped rotorcraft awaiting departure clearance can be subjected to the same delays as fixed-wing aircraft in foggy weather with temperatures conducive to induction system icing. The FAA agrees that, as a general practice, rotorcraft cannot expect preferential handling or to avoid queuing up at runways. Furthermore, the operation of a helicopter rotor system can itself, within the proposed envelope:

- (1) Intensify icing conditions when ground fog on freezing drizzle under stable cloud layers is present; and
- (2) Generate freezing ground fog when atmospheric conditions are close to forming natural freezing fog.

Other commenters contend that no rotorcraft have been certificated for intentional flight in icing conditions. The FAA considers this contention somewhat irrelevant in considering ground induction icing conditions. As mentioned above, ground operation can produce induction system icing without the existence of conditions conducive to in-flight icing as defined in Appendix C of Part 25 of the FAR.

Considering the above, and after further review, the FAA sees no justification for excluding rotorcraft from § 33.68(b) and has revised the proposal accordingly.

It also is suggested that a certification time of less than the 30-minute idle specified in the proposed amendment could be applied to rotorcraft engines. This suggestion may have merit, but it is believed that additional operating data are required to support a lower test time. This question will be considered in future rulemaking.

Concerning the envelope to use for testing, one commenter suggests using more general terms to describe the icing envelope, while another suggests adoption of a somewhat more severe military specification.

As was presented during the Aircraft Engine Regulatory Review Conference,

recorded meteorological data, from the most severe ground icing experience during civil operation, does not support more stringent criteria. Therefore, the FAA does not agree with the proposal to adopt the military specifications.

In response to the comment to state the requirements in broad terms, the proposed regulation as stated presents minimum atmospheric parameters for all engines to meet. A lack of specific requirements could lead to a generation of engines all meeting different atmospheric conditions. This would not lead to uniformity in the certification process.

One comment was received opposed to allowing periodic engine run-up to shed ice. The comment was based on the possibility of icy taxiways and run-up pads making this procedure risky. The FAA agrees that this comment has merit under certain conditions. However, there are installations where this procedure could be perfectly acceptable under adverse ground conditions. Rotorcraft operation is one such application. The relaxatory nature of this part of the regulation need not be denied applications where safety is not compromised. It should be noted that the manner of this procedure may be controlled by limitations in the engine data sheet and/or operating instructions if appropriate. It is envisioned that run-up power excursions that are excessive or operationally untenable will be disallowed.

Therefore, with the exception of the change to § 33.68(b) discussed earlier, the proposal is adopted without change.

Proposal 76. This amendment to § 33.71 revises the standards for engine lubrication systems and makes them consistent with proposed §§ 23.1019 and 23.1021 and corresponding changes to Parts 25, 27, and 29.

A commenter disagrees with the proposal to delete the requirement for a strainer or filter ahead of each scavenge pump, stating that protecting the scavenge pump is essential to safe operation. The commenter adds that the rule already allows the applicant to size the strainer as needed to protect the pump. The FAA believes that design flexibility should be carried even further and that the need for a scavenge strainer/filter and its sizing should be determined by the engine designer.

Another commenter suggests that § 33.71(b) be further amended to read: "There must be an oil strainer or oil filter, other than at the oil tank outlet, through which all of the engine oil flows." However, this change would not provide additional clarity and would add an unnecessary restriction.

A commenter suggests that § 33.71(c)(5) be amended or deleted to permit marking the word "oil" on adjacent cowlings instead of the engine oil tank oil filler and that the corresponding aircraft rule be amended to conform. Sections 23.1557, 25.1557, 27.1557, and 29.1557 already specify exterior markings as suggested by the commenter. The proposed oil tank filler marking drops the capacity requirement from the current rule but retains the "oil" marking in the interest of safety.

A commenter suggests that proposed § 33.71(c)(12)(ii) call for provision of makeup oil equivalent to that expected to leak from a deteriorated engine. The FAA believes that this requirement is implicit in the proposed rule and would have to be met by airworthy engines under § 33.19 and 33.75.

A commenter suggests that proposed § 33.71(f) be deleted because loss of lubrication during "negative g" operation has not been a problem in commercial service. Another commenter suggests deleting the reference to § 25.333 in this section since engines for general aviation fixed-wing and rotary-wing applications do not necessarily comply with it. The commenter further suggests that the amendment require the applicant to define the maximum applied loads as in § 33.23 for mounting attachments. The FAA has no records to indicate the extent of the problem with engine lubrication during negative g operation, and it is correctly noted that a Part 25 requirement should not be imposed on an engine not intended for Part 25 application. The present regulations covering lubrication system design for both reciprocating and turbine engines have been found adequate. The proposed new paragraph (f) is withdrawn as recommended, and the remainder of the proposal is adopted without change.

Proposal 77. This amendment adds a new § 33.74 which defines thrust or power augmentation systems for transport category airplanes.

After further consideration, the FAA has found it to be impractical for an engine manufacturer to comply with § 25.945 as referenced in the new section since this paragraph requires detailed knowledge of the aircraft engine installation, aircraft flight envelope, and power augmentation system hardware supplied by the manufacturer for each aircraft type. This information is seldom available to the engine manufacturer at the time of engine certification. The proposed amendment therefore is withdrawn.

Proposal 78. Two commenters object to the word "hazardous" as proposed for § 33.75, which amplifies and redefines

burst limits and corrects a reference to allowable loads in amended § 33.23. They submit that an engine manufacturer is not in a position to judge what is hazardous at the time of engine certification. The commenters recommend using "release of fragments having significant residual energy" as the burst criterion.

The FAA disagrees. Released fragments are important because they may represent a hazard to the aircraft. The hazard may be related to residual energy, but even fragments which have a low residual energy may constitute a hazard. Judgment must be used under either definition by the manufacturer and the FAA during certification to determine what is hazardous. Section 33.75(b), therefore, except for the descriptive parenthetical statement, is adopted as proposed. Reference to § 33.23(b)(2) in proposed paragraph (c) is corrected by substituting § 33.23(a).

Proposal 79. This amendment adds a new § 33.76, which applies the standards of § 25.933, airplane reversing systems, to engine airworthiness.

Two commenters object to the proposed amendment on the grounds that compliance requires an evaluation of the engine thrust reverser as a part of a particular aircraft reversing system. The engine manufacturer cannot anticipate or have available the aircraft design and performance data necessary to comply with § 25.933 (a) and (b). The FAA agrees, and this proposal is withdrawn.

Proposal 80. This amendment to § 33.77 updates the engine foreign object ingestion requirements. For comments on the amendment to § 33.77 (a)(2) and (a)(3), see the proposals for § 33.75 (b) and (c), respectively.

A commenter expresses the opinion that ingestion tests should be conducted with simulated engine installation hardware and gearbox loading. The FAA finds merit in these comments but considers the suggested changes beyond the scope of the NPRM. The FAA will review these suggestions for future rulemaking action.

A commenter questions whether an engine running for 5 minutes following the bird ingestion event is adequate. In the absence of an obviously dangerous condition, however, the 5-minute run time is sufficient to demonstrate engine integrity. This commenter also suggests that in addition to the other requirements, any potentially hazardous physical damage following the bird test be considered a failure. The FAA has made this a practice in the past, and the section is changed accordingly.

A commenter submits information from an actual aircraft accident which

suggests that bird ingestion certification requirements should be made stricter. The accident cited involved an engine certificated before the current requirements were adopted at a time when less demanding tests were the rule, so that the commenter's remarks may not be currently relevant. The FAA is continually reviewing bird ingestion incident data in terms of possible rulemaking action.

A commenter objects to deletion of the sand and gravel ingestion requirement, stating that the absence of sand/gravel ingestion problems in service is due to the presence of the requirement in the current rule. The commenter points out that in addition to blade erosion, adverse effects on engine seals, bleed ports, and oil sumps may lead to in-flight operating abnormalities. Although it is recognized that sand and gravel ingestion may adversely affect various turbine engine mechanisms, service experience has shown that ingestion of these materials does not possess the potential for causing sudden loss of engine power as does other ingested matter. On this basis, the requirement is withdrawn.

A commenter points out that the specified 4 percent water to air ratio is less than that which may be encountered in the atmosphere and also suggests conducting water ingestion tests at altitude conditions. The FAA agrees that in some severe rain conditions, the water to air ratio exceeds 4 percent but considers that such occurrences represent an environmental extreme rarely encountered in service. Incorporating an increased water-to-air ratio or imposing altitude conditions on the water ingestion requirements are beyond the scope of this review. The FAA will continue to review ingestion tests requirements for possible rulemaking action in the future.

Several commenters question the requirement to maintain a 4 percent water-to-air ratio during acceleration and deceleration of the engine. Two of these commenters also question how evaporative effects are to be accounted for in the water-to-air ratio. It is suggested that the wording of § 33.77(c) be changed to "while ingesting water following stabilized operation. . . ." The FAA intends that the 4 percent water-to-air ratio be maintained during transients to simulate actual conditions. It is not expected that this ratio will be maintained exactly but that a minimum of 4 percent water-to-air ratio will be used during transients. The practicality of such testing has been demonstrated.

The goal of water ingestion tests is to simulate flight in heavy rain in which saturation of the air is assumed. If the engine air available during the certification test is not saturated, additional water must be added to ensure a 4 percent liquid water-to-air ratio at the engine inlet. The proposal for § 33.77(c) is changed to clarify this intent.

A commenter recommends that § 33.77(d) be further amended to require protection from pieces of objects which, although unable to pass through the protective device when whole, may break apart upon striking the protective device and enter the engine. This protection is already provided under proposed § 33.77(d) since it does not exempt from demonstration foreign objects of a size which will pass through the protective device.

Two commenters recommend further amending § 33.77(d)(3) to read "... sustained reduction in power or thrust greater than those values required by paragraphs 33.77 (b) and (c)." The FAA agrees. The intent is not to require greater thrust recovery for engines with protective devices than for those without them. The proposed rule is changed as recommended.

One commenter disagrees with the wording of § 33.77(e) under ice test quantity. The words "typical inlet cowl" are intended to mean an inlet cowl typical of an installation of the engine being tested. The "slab of ice" is intended to be of a size and weight which provides a test of at least equal severity to the inlet cowl and engine face ice accumulation. The meaning of these phrases is clear, and the proposed wording is adopted.

One commenter objects to the proposed distinction in § 33.77(e) between engines with inlet guide vanes and engines without inlet guide vanes in the 4-pound bird injection test conditions. The commenter states that service records do not justify such a distinction and that bird injection is an environmental condition not related to fan/inlet design. However, there is reason to distinguish between turbine engines with and without inlet guide vanes in order to test each design under its most critical bird ingestion condition. This does not imply a difference in environment but is believed to provide the best test for each design type. FAA report No. FAA-RD-77-55, "Improved Resistance to Engine Bird Ingestion," dated March 1977, indicates that rotating blade damage is inversely proportional to the entering velocity of the bird due to the addition of the bird velocity vector and the blade velocity vector. An engine with inlet guide vanes

is likely to be struck on a vane rather than a blade, and the vane damage will increase with increasing bird velocity. The proposed wording is retained. The FAA will continue to study the bird ingestion hazard.

Proposal 81. This amendment to § 33.83 broadens the vibration test requirements and affords added flexibility to the test methods.

Two commenters suggest that the title be changed in order to better describe the purpose of the test and avoid confusion with §§ 33.33 and 33.63. The FAA disagrees. Section 33.33 is a requirement for the design of reciprocating engines, § 33.63 is a similar requirement for design and construction of turbine aircraft engines, while § 33.83 relates to the block testing of aircraft turbine engines. Section 33.63 is a design consideration for turbine engines, whereas § 33.83 is a substantiation means.

Two commenters object to the use of the term "maximum permissible takeoff speed" since takeoff speed may not be the maximum permissible speed for certain engines. The FAA agrees, and the word "takeoff" is deleted from the first sentence of § 33.83(a).

Three commenters object to the wording of § 33.83(b) concerning acceptable methods for showing compliance. One commenter suggests that stress margins which are appropriate to the components being evaluated be recognized, while the others maintain that compliance can be shown by engine test as well as by analysis. The FAA agrees with both comments but believes the proposed wording is adequate. Each method of showing compliance with this section during the certification process is reviewed by the FAA.

Another commenter suggests insertion of the word "hazardous" before "failure" in § 33.83(a). The commenter points out that there could be minor failures during this test. The FAA considers that all failures should be evaluated in terms of each engine design, as the distinction between minor and hazardous conditions cannot always be pre-established for a new design.

A commenter suggests that some clarification of the term "loading device" would be of assistance. As used in this regulation, the term "loading device" (i.e., dynamometer) applies primarily to turboshaft and turboprop engines. Turbofan and turbojet engines are not usually loaded externally during the endurance test. The intent of this regulation is to assure that the turboshaft and turboprop engines are

loaded in the same manner as during the endurance test.

The amendment to § 33.83 is adopted as proposed except for the change described.

Proposal 82. This amendment to § 33.87 clarifies the 150-hour endurance test procedure, provides alternative means of compliance, and adjusts the test schedule for helicopters.

One commenter questions the validity of conducting the endurance test of an accessory drive and mounting attachment on a separate rig, as provided by proposed § 33.87(a)(6). The commenter suggests that rig testing be supplemented by running the accessories on an engine. The FAA has found that when properly conducted, the gearbox rig tests with accessory loading provide sufficient data for endurance certification. In addition, such tests are often a more practical solution to the problem of environmental control and data collection encountered during endurance engine running. The accessory weights and overhung moments must be simulated during full engine testing, but power extraction effects may be substantiated by rig test.

A commenter suggests eliminating operation at rated 2½-minute power during the third and sixth takeoff power periods for one of the twenty-five 1-hour sequences specified by current § 33.87(d)(1). The commenter argues that proposed § 33.87(d)(2) increases the cumulative endurance test time at the 2½-minute power condition and that the increase should be compensated for in § 33.87(d)(1). The FAA does not agree. One reason for including proposed § 33.87(d)(2) is to establish a margin of safety for the 2½-minute power rating. Compensation for the increased time at 2½-minute power would cancel, to some extent, the intent of the proposal. The FAA recognizes that the total time required at 2½-minute power will be increased by 5 minutes but does not consider this increase to be significantly burdensome. However, the wording of proposed § 33.87(d)(2) is revised to make it clear that the 5-minute test at 2½-minute power is to be included within, rather than in addition to, the 30-minute test period.

One commenter requests that an "Emergency Power Rating" (EPR) be established for rotorcraft. The EPR would be a power greater than 2½-minute power and used for one engine inoperative takeoff in multiengine rotorcraft. The EPR would be permitted for up to a 30-second duration. The commenter proposes that the 30-second EPR be included in the 150-hour endurance test in this section. The FAA

finds that although this proposal has merit, it is beyond the scope of the Engine Review. Therefore, the amendment to § 33.87 is adopted as proposed except for the changes described.

Proposal 83. This amendment to § 33.88 relieves the overtemperature test requirements by reflecting actual conditions more realistically.

One commenter recommends less reduction in test time than that proposed and suggests that such a reduction be made based on analysis of service experience that shows this to be acceptable. The commenter also recommends that the second sentence be revised to state that the turbine assembly be within dimensional limits established for allowing it to remain in continued service.

The FAA does not agree that the time reduction is drastic since engines certified before Amendment 33-6 were in fact tested for the 5-minute condition. Service experience with these engines, with regard to overtemperature capability is excellent. Additionally, all post-Amendment 33-5 certified engines have been granted exemptions from the existing 30-minute requirement and were tested for 5 minutes as is now proposed. The dimensional limits quoted in the proposal are in fact service limits as suggested by the commenter, which are determined during the certification process. Therefore, the FAA finds further clarification to be redundant.

Another commenter objects that the engine overtemperature test requirements inherently involve blade creep life, which is considered an economic item rather than an airworthiness item. The commenter states that the true need is to evaluate rotor disc integrity under conditions of possible overtemperature due to disc cooling system failure which might result in temperatures higher than the specified 75°F above maximum rated. The FAA position is that the regulation will ensure that the turbine assembly can satisfactorily withstand an overtemperature of 75°F above the maximum operating temperature for a period of time consistent with what could reasonably be expected in service. The test is designed to evaluate gross effects of a 5-minute overtemperature condition on the engine turbine assembly, which includes blades, discs, drums, spacers, shafts, seals, stators, nozzles, and support structure. Therefore, § 33.88 is adopted as proposed.

Proposal 84. This amendment to § 33.89 broadens the operational test requirements by calling for testing, if

necessary, throughout the operating envelope of the engine.

A commenter complains that the tests do not demonstrate that rapid throttle movement does not constitute an operational hazard. It should be noted that § 33.89(a), through reference to § 33.73, requires demonstrating rapid throttle movement from minimum to maximum position. This commenter also considers it unreasonable to expect flight crewmembers to monitor engine controls during emergency conditions. The FAA, on the contrary, considers it reasonable to expect pilot monitoring and appropriate manipulation of engine controls within the context of the operational situations addressed by this comment.

One commenter objects that the proposed change has the same meaning as the current regulation while being less explicit. However, the proposed amendment contains all of the previous considerations implicitly within the new wording and at the same time has been expanded to include the entire operating envelope of the engine. Accordingly, the proposed rule is adopted without change.

Proposal 85. This amendment to § 33.90 discontinues use of the word "overhaul" and recognizes the validity of alternative maintenance programs.

One commenter suggests that the rule approve the process of reconditioning after test and inspection if it is determined that such process is required. The FAA agrees that if the test results show that maintenance action is required, it should be so specified. Another commenter suggests that substituting "initial maintenance inspection" for "overhaul test" merely replaces one contentious phrase with another and urges that § 33.90 be deleted as being unnecessary to safety. The FAA does not agree since not all Part 33 turbine engines come under the regimen of a structured reliability program. Recent experience with two new engine certification programs under current rules has shown the need for an initial inspection interval of certain hot section components. Significant deterioration of engine operating and performance characteristics would exist without the specified inspection and repair requirements. Accordingly, the proposed amendment is adopted with the change noted above.

Proposal 86. This amendment to § 33.92 deletes the windmilling test requirement for subsonic turbine engines and amplifies the rotor burst and load limitations as in the proposal for § 33.75(b).

In addition to comments previously discussed for § 33.75, two commenters

question deleting the windmilling test requirement for subsonic engines. The commenters suggest that existence of the current requirement may account for the lack of service problems associated with windmilling engines. The FAA disagrees. Most engines currently in service have a certification basis which predates the windmilling test requirement of § 33.92 but, nevertheless, have accumulated years of service with no reported incidents of windmilling hazards. It has not been demonstrated that an engine test of windmilling capability is required for all subsonic engines.

One commenter recommends adding a requirement that the applicant provide evidence to show that the engine windmilling without lubricating oil would not result in a condition which would jeopardize the aircraft. The FAA agrees but believes that § 33.75 provides this assurance. Proposed § 33.92 therefore is adopted with the addition of the reference to mount load limits as proposed for § 33.75.

Proposal 87. No comment was received on the proposal to amend § 33.93(b) by substituting the word "part" for "component" to preclude ambiguity, and the proposal is adopted without change.

Proposal 88. This amendment provides a new § 33.94 which adds blade failure containment testing of engines for certification.

Several commenters object to the requirement of § 33.94(a) that the engine run for at least 15 seconds before initiating shutdown after the event, claiming that it is unduly restrictive. They state that an engine which shuts down in less than 15 seconds would be acceptable, provided it does not burst, catch fire, or generate excessive mount loads. The same commenters propose that § 33.94(a)(1) be changed to permit use of component rig containment tests to supplement the engine test whenever facility limitations prevent attaining maximum permissible speed on a complete engine.

The FAA agrees that certain engines may not be able to operate for 15 seconds after the failure event. Accordingly, § 33.94(a) is modified to allow for instances where the resulting damage prevents the engine running for the required 15 seconds.

The FAA agrees that rig tests are valid, as reflected in proposed § 33.94(b), and in fact manufacturers' rig tests are being used to supplement complete engine blade containment tests for certification purposes. It is concluded, however, that such determinations will be made on a case-

by-case basis under the authority provided by proposed § 33.94(b).

Another commenter suggests that § 33.94(a)(2) should be changed so that the engine test is based on the most critical engine casing temperature rather than the most critical turbine blade. Analysis leading to determining the most critically operating turbine blade would be expected to include analysis of case material properties at critical temperatures in an engine operating at maximum permissible r.p.m. Therefore, additional clarification is not considered necessary, and the amendment to paragraph (a)(2) is adopted as proposed.

Regulatory Evaluation

The FAA conducted a detailed regulatory evaluation which is included in the regulatory docket. Based on a review of available FAA data, cost data supplied by the Aerospace Industries Association (AIA) and the General Aviation Manufacturers Association (GAMA), and data from the National Transportation Safety Board (NTSB) accident data file, FAA determined that this overall rule provides cost savings that substantially outweigh the additional costs imposed on society.

The amendments in this final rule provide benefits in the aggregate to the aviation public, most specifically to airframe and engine manufacturers. These amendments provide general benefits by deleting obsolete requirements and clarifying the text, by updating and modernizing technical requirements to reflect engineering advances in the state-of-the-art, by reflecting the changing interface between the airframe and engine manufacturers, and by taking into account FAA accumulated service experience. This rule imposes no costs on the Federal Government.

Industry estimates of costs and benefits provided to the FAA for specific amendments were aggregate undiscounted 10-year estimates stated in 1981 dollars. The FAA was unable to break down these aggregate estimates into annual estimates because of the uncertainty of the number of new type certificated engines and aircraft models in a given year as well as the subsequent production of these engines and aircraft in a given year. Furthermore, industry was unwilling to supply information pertaining to the number of companies impacted by each of these amendments, or specific information on the number of estimated new type certificated engines and aircraft in a given year as well as subsequent production estimates, for reasons of individual company confidentiality.

Since it was assumed the Aircraft Engine Regulatory Review initiative would become final rule in 1983, the FAA adjusted the cost estimates to 1983 dollar values and then discounted these values for the years 1984 and 1992 to arrive at a range of values for the 10-year period of 1983-1992. The FAA did this because it was not known in which of these years the costs and benefits associated with the proposals would occur; therefore, by discounting the values in 1984 (assuming all benefits and costs occur in this year would result in the highest possible discounted values) and in 1992 (assuming all benefits and costs occur in this year would result in the lowest possible discounted values), a representative range is developed. The discount rate for 1984 is 0.91 and the discount rate for 1992 is 0.38. This range was conducted for all beneficial or cost imposing proposals except § 23.903(b) where FAA was able to obtain more refined data.

Major Benefits—Regulatory amendments that are expected to yield major benefits are summarized below (first-order discounted cost savings are stated in 1983 dollars and represent the range of savings for the 10-year period of CY 1983 through CY 1992):

1. Section 23.903—The proposal allows the use of satisfactory foreign object ingestion (FOI) service experience for turbine engines as an alternate to meeting § 33.77 in effect on October 31, 1974, or as subsequently amended, to be eligible for installation. Currently, an airframe manufacturer would have to conduct FOI tests on any inservice turbine engine that is installed on a new airplane even though the engine may have a satisfactory FOI service experience. Estimated discounted test cost savings from eliminating this requirement in terms of 1983 dollars are \$2.11 to \$5.05 million for the period of CY 1983-1992.

Considerable costs could be imposed on airframe manufacturers that choose to install engines certified to Part 33 FOI requirements prior to October 31, 1974, on future type certificated airplanes that have a bad FOI service experience. FAA considers that those instances would be rare from a technological state-of-the-art standpoint.

2. Section 33.14—This proposal provides engine manufacturers with more latitude in the type of procedures they can use for establishing low-cycle fatigue service lives for rotating components and for increasing these lives. This proposal also increases the applicability of the rule, redefines the term "start-stop stress cycle," and permits an alternative to parts temperature stabilization if justified.

The current rule is unduly restrictive, because it prescribes only a fixed reduction factor for determining the initial service life and only one method for increasing these lives based on testing of parts removed from service. Estimated discounted test cost savings in terms of 1983 dollars are \$16.15 to \$38.69 million for the period of CY 1983-1992.

3. Section 33.68—This proposal relaxes the 30-minute idle with freezing fog requirement test criteria, permits periodic engine runups, and permits temperature variation, all with regard to induction system icing. The current test requirement is unnecessarily severe because it is outside the maximum icing envelope of Appendix C of Part 25, and because no tolerances are permitted on the temperature and liquid water content. Program and production cost savings will be achieved through reduced anti-icing system hardware and installation costs and through simplification of the engine design and manufacturing process. Specifically, this amendment eliminates in almost all cases the design and installation of components for a supplementary heating system. Estimated discounted savings in terms of 1983 dollars are \$214.02 to \$517.17 million for the period of CY 1983-1992.

4. Section 33.71—This amendment deletes the requirement for scavenge oil strainers and marking oil tank filler capacity. Service experience shows that scavenge oil strainers do not necessarily improve safety but do tend to restrict design of the oil system. There is no safety need to mark tank capacity on the oil tank filler. Estimated discounted component, installation, and labor cost savings in terms of 1983 dollars are \$2.11 to \$5.05 million for the period of CY 1983-1992.

5. Section 33.77—This proposal eliminates the tire, sand, and gravel FOI test requirements. The tire test requirement is deleted because service experience has shown that hazardous consequences from ingestion of a piece of tire are no greater than those associated with ingestion of a 4-pound bird. Furthermore, service experience has shown that ingestion of sand and gravel does not possess the potential for causing sudden loss of engine power as does other ingested matter. Eliminating these requirements will result in some test cost savings and reduced hardware (engine) burnup. Estimated discounted test cost savings in terms of 1983 dollars are \$9.62 to \$23.02 million for the period of CY 1983-1992.

6. Section 33.83—This proposal allows the use in certain cases of a modified

version of the endurance test loading configuration for the required vibration survey which would enable the use of a modified configuration if that loading device is incompatible with the necessary vibration instrumentation. The current regulation is unduly restrictive because it requires that the vibration survey must be conducted using the same configuration of the loading device which is used for the endurance test. A comparable test on the engine will serve the same results. Estimated discounted labor cost savings in terms of 1983 dollars are \$4.18 to \$10.01 million for the period of CY 1983-1992.

7. Section 33.87—This section allows separate, more convenient rig testing of accessory drives and mounting attachments. The FAA has found that gearbox rig tests with accessory loading provide comparable data to endurance certification tests. The current regulation requires that load testing of accessory drives and mounting attachments must be performed on the engine. The FAA has found this to be too stringent a requirement. There will be possible small cost savings in equipment to operate the accessory drive. Estimated discounted cost savings in terms of 1983 dollars are \$1.17 to \$2.80 million for the period of CY 1983-1992.

8. Section 33.88—This proposal reduces the duration of the overtemperature test from 30 minutes to 5 minutes. The current rule has been found unnecessarily severe since service experience has shown that none of the turbine engines subjected to 5-minute overtemperature tests have experienced inservice rotor disc primary failure due to overtemperature. Significantly reducing the duration of the overtemperature test adequately demonstrates the integrity of rotor discs without subjecting them to unnecessarily hazardous conditions and saves development of hardware for blades, discs, drums, etc. Estimated discounted test and hardware cost savings in terms of 1983 dollars are \$9.03 to \$21.62 million for the period of CY 1983-1992.

9. Section 33.92—This amendment deletes the windmilling without oil test for subsonic turbine engines. There have been no reported incidents involving windmilling hazards to aircraft resulting from loss of engine oil, and it has not been demonstrated that an engine test of windmilling capability is required. Estimated discounted test cost savings in terms of 1983 dollars are \$0.96 to \$2.30 million for the period of CY 1983-1992.

Major Costs—Regulatory amendments that are expected to

impose major costs are summarized below (first-order discounted costs are stated in 1983 dollars and represent the range (except \$ 23.903) of new costs imposed for the 10-year period of CY 1983 through CY 1992):

1. Section 23.903—This amendment requires that design precautions be incorporated in Part 23 certified airplanes to protect these airplanes from uncontained rotor failure events. As the use of turbine engines on Part 23 certified airplanes increases, especially in for-hire operations, airplanes certified under Part 23 should be afforded the same level of safety from uncontained rotor failures as airplanes certified under Part 25. The FAA obtained information pertaining to two cases in the past 10 years involving uncontained rotor failures in Part 23 certified airplanes. In terms of 1983 dollars, the cost of these accidents (injuries and aircraft damage) is approximately \$1.1 million based on values contained in the *Economic Values for Evaluation of FAA Investment and Regulatory Programs*. Assuming that this proposed rule would protect against all uncontained rotor failure events, \$0.93 to \$2.2 million is the discounted exposure adjusted benefit (cost savings) range for a 10-year period beginning CY 1983. These estimates include the projected increase in the number of hours flown by turbine-powered general aviation airplanes. It is noted in both cases that uncontained rotor failure was the secondary cause of these accidents (incidents), both of which were precipitated by worn components in the gear assemblies according to the NTSB. It is also noted that this rule is proposed in order to prevent a future problem in certain Part 23 airplanes because installation of turbine engines in these airplanes is expected to increase significantly in the next 10 years. Furthermore, a significant increase in the number of Part 23 certified turbine-powered airplanes used in air taxi and corporate operations is expected, and the FAA believes that protection comparable to that required under Part 25 is needed when carriage of passengers is involved.

This requirement places an economic burden on the manufacturers of these small airplanes. This requirement may influence future airframe design in areas such as armor protection and engine location.

In an attempt to derive cost estimates, the FAA contacted GAMA and various airframe manufacturers. Most of these organizations indicated that the proposed regulation would impose significant costs, but they were not able to provide specific estimates because of

the complexity of the issues and the amount of time it would take to compile estimates. Additionally, the extent of specific design changes to future type certificated airplanes was not immediately known.

One industry organization estimates that the cost to the manufacturer of compliance per airplane could easily reach \$20,000, including increased engine price, cost of materials, design, development, testing, tooling expense, labor, and normal factory overhead. Specifically, this organization stated that the typical engine would require a containment shield (using a Kevlar fabric which is believed to be the most weight efficient installation) and that design adjustments would be required to provide for proper cooling, assurance of cowling drainage, and access to service points. Furthermore, the organization stated that considerable engineering and flight test development would be involved in assuring that maintenance could be accomplished on the engine, and the development of ballistic confirmation tests and certification would be extensive. The FAA ascertained through discussions with industry that an estimated 10 new turbine-powered airplane models would be eligible to be certified to Part 23 standards during the next decade. Because it is not certain in what years these airplane models will be certified, the FAA assumes that one airplane will be certified each year from 1983 through 1992. Furthermore, the projected production levels for each of these models in future years is not known. Based on past production levels of certain Part 23 turbine-powered airplanes, the FAA assumes an average annual production of 75 airplanes for each newly-certified model in each year following the year of certification.

Using this assumption, 3,375 airplanes will be manufactured between 1983-1992 of models which were newly-certified to Part 23 during this period.

The following table shows that the discounted value of costs over the 10-year period of 1983-1992 in 1983 dollars of requiring design precautions to minimize rotor failure events is \$37.8 million. It assumes that the cost of compliance per airplane is \$20,000. These are first-order costs which are initially borne by the airframe manufacturers, and the costs do not take into account the effect of increased prices with respect to the impact on domestic sales and foreign competition implications.

DISCOUNTED VALUE OF COSTS OF PROPOSED RULE

Year	Airplane production	Cost of compliance per airplane	Present worth discount	Discounted value of cost of rule
1983	0	\$20,000	1.00	0
1984	75	20,000	.91	\$1,365,000
1985	150	20,000	.83	2,490,000
1986	225	20,000	.75	3,375,000
1987	300	20,000	.68	4,080,000
1988	375	20,000	.62	4,650,000
1989	450	20,000	.56	5,040,000
1990	525	20,000	.51	5,355,000
1991	600	20,000	.47	5,640,000
1992	675	20,000	.43	5,805,000
Total	3,375			37,800,000

This rule would also impose certain second-order costs on purchasers of these airplanes in terms of increased inspection costs (removing and installing the system at each inspection interval) and decreased airplane performance due to a maximum 100-pound increase in airplane empty weight. The benefit/cost considerations may improve because increased use of turbine engines in Part 23 certified airplanes will increase the risk of rotor failure accidents.

2. Section 25.1091—This amendment requires that the FOI criteria of § 33.77 be applied to vulnerable portions of the air induction system such as inlet splitter vanes, duct-mounted instrumentation, and annular rings. Parts of the air induction system such as annular rings and splitter vanes are physically located in front of the engine. These parts were installed to reduce engine inlet noise in a limited number of airplanes. If these components are included, they should be subject to the same FOI requirements as the engine because of their possible breakoff into the engine. Most aircraft induction systems do not use splitters, etc., and therefore most aircraft designs would not be affected by this rule. This requirement was inadvertently left out of Amendment 33-6 in 1974. The estimates of the discounted cost range of improved materials and testing for these specific items to meet the criteria of § 33.77 in terms of 1983 dollars are \$2.11 to \$5.05 million for the 10-year period of CY 1983-1992. However, the actual cost of compliance will be much lower because compliance with FOI standards may be shown by analysis as well as testing, and the FAA sees little application of such devices in the future.

3. Section 33.77—This amendment requires that a 4 percent water-to-air ratio be maintained during transients in order to simulate actual flying maneuvers in heavy rain. The current rule requires that the ratio be maintained only for takeoff and idle

conditions but does not require any demonstration of the ability to accelerate or decelerate safely under water ingestion conditions. Such ability is essential for safe flight in heavy rains. The FAA obtained information pertaining to one case in the past 10 years involving turbine engine failures due to water ingestion during transients, a Southern Airways accident in 1977. The NTSB reported that the probable cause of the accident was a loss of thrust of both engines while penetrating severe thunderstorms. The NTSB also reported the accident resulted from a loss of thrust caused by ingestion of massive amounts of water and hail which, in combination with thrust lever movement, induced severe stalling in and major damage to the engine compressors.

In terms of 1983 dollars, the cost of this case (injuries and aircraft damage) based on values contained in the *Economic Values for Evaluation of FAA Investment and Regulatory Programs* is approximately \$47.0 million. Assuming that this proposed rule would protect against all accidents and incidents involving turbine engine water ingestion, \$39.29 to \$94.09 million is the discounted exposure adjusted benefit range (cost savings) for the period of CY 1983-1992. This estimate includes the projected increase in the number of hours flown by turbine powered aircraft.

This amendment would require engine manufacturers to conduct a more precise water ingestion test and to collect more test data to verify engine performance as it relates to water ingestion. It could require the engine manufacturer to purchase additional test equipment. The estimated additional discounted cost to the engine manufacturers to perform this test in terms of 1983 dollars is \$1.05 to \$2.50 million for the period of CY 1983-1992.

The first-order discounted benefit and cost ranges of these major proposals are summarized in Table 1. This table shows that the most conservative benefit/cost ratio for the entire evaluation is \$299.57 to \$45.35 million of 6.61 to 1.00.

TABLE 1¹—AIRCRAFT ENGINE REVIEW BENEFIT/COST MATRIX BY MAJOR AMENDMENT, FOR THE 10-YEAR PERIOD OF CALENDAR YEAR 1983 THROUGH CALENDAR YEAR 1992

[Dollars in millions]					
FAR		Benefits		Costs	
23	23.903(a)(2)	\$2.11	\$5.05		
	23.903(b)	0.93	2.22	\$37.80	\$37.80
	Subtotal	3.04	7.27	37.80	
25	25.1091(e)			2.11	5.05

TABLE 1¹—AIRCRAFT ENGINE REVIEW BENEFIT/COST MATRIX BY MAJOR AMENDMENT, FOR THE 10-YEAR PERIOD OF CALENDAR YEAR 1983 THROUGH CALENDAR YEAR 1992—Continued

[Dollars in millions]					
FAR		Benefits		Costs	
27	Subtotal			2.11	5.05
29	Subtotal				
33	33.14	16.15	38.69		
	33.68	214.02	517.17		
	33.71(b)	2.11	5.05		
	33.77	48.91	\$117.11	1.05	2.50
	33.83(a)	4.18	10.01		
	33.87(a)(b)	1.17	2.80		
	33.88	9.03	21.62		
	33.92(c)	0.96	2.30		
	Subtotal	299.57	714.75	1.05	2.50
	Total	299.57	722.02	40.96	45.35

¹ Benefit and cost values are stated in 1983 dollars.
* Of this amount, \$39.29 million to \$94.05 million is the benefit attributed to an accident caused by water ingestion.

List of Subjects

14 CFR Part 23

Air transportation, Aircraft, Aviation safety, Safety, Tires.

14 CFR Part 25

Air transportation, Aircraft, Aviation safety, Safety, Tires.

14 CFR Part 27

Air transportation, Aircraft, Aviation safety, Safety, Tires.

14 CFR Part 29

Air transportation, Aircraft, Aviation safety, Rotorcraft, Safety, Tires.

14 CFR Part 33

Air transportation, Aircraft, Aviation safety, Engines, Safety.

Adoption of Amendment

Accordingly, Parts 23, 25, 27, 29, and 33 of the Federal Aviation Regulations (14 CFR Parts 23, 25, 27, 29, and 33) are amended as follows, effective March 26, 1984.

PART 23—AIRWORTHINESS STANDARDS: NORMAL, UTILITY, AND ACROBATIC CATEGORY AIRPLANES

1. By revising § 23.901(d) to read as follows:

§ 23.901 Installation.

(d) Each turbine engine powerplant must be constructed, arranged, and installed to provide continued safe operation without a hazardous loss of

power or thrust for a period of 3 minutes each at rated takeoff power or thrust and flight idle in rainfall with an ambient liquid water content of not less than 4 percent of engine airflow by weight.

2. By revising § 23.903 (a) and (b) to read as follows:

§ 23.903 Engines.

(a) Engine type certificate.

(1) Each engine must have a type certificate.

(2) Each turbine engine must either—

(i) Comply with § 33.77 of this chapter in effect on October 31, 1974, or as later amended; or

(ii) Be shown to have a foreign object ingestion service history in similar installation locations which has not resulted in any unsafe condition.

(b) Turbine engine installations. For turbine engine installations—

(1) Design precautions must be taken to minimize the hazards to the airplane in the event of an engine rotor failure or of a fire originating inside the engine which burns through the engine case.

(2) The powerplant systems associated with engine control devices, systems, and instrumentation must be designed to give reasonable assurance that those operating limitations that adversely affect turbine rotor structural integrity will not be exceeded in service.

3. By revising § 23.905(a) to read as follows:

§ 23.905 Propellers.

(a) Each propeller must have a type certificate.

4. By revising § 23.975(b) to read as follows:

§ 23.975 Fuel tank vents and carburetor vapor vents.

(b) Each carburetor with vapor elimination connections and each fuel injection engine employing vapor return provisions must have a separate vent line to lead vapors back to the top of one of the fuel tanks. If there is more than one tank and it is necessary to use these tanks in a definite sequence for any reason, the vapor vent line must lead back to the fuel tank to be used first, unless the relative capacities of the tanks are such that return to another tank is preferable.

5. By revising § 23.994 to read as follows:

§ 23.994 Fuel system components.

Fuel system components in an engine nacelle or in the fuselage must be protected from damage which could result in spillage of enough fuel to constitute a fire hazard as a result of a wheels-up landing on a paved runway.

6. By adding a new § 23.995(g) to read as follows:

§ 23.995 Fuel valves and controls.

(g) Fuel tank selector valves must—

(1) Require a separate and distinct action to place the selector in the "OFF" position; and

(2) Have the tank selector positions located in such a manner that it is impossible for the selector to pass through the "OFF" position when changing from one tank to another.

7. By amending § 23.997 by removing the term "and the mesh" from paragraph (d) and by revising paragraph (c) to read as follows:

§ 23.997 Fuel strainer or filter.

(c) Be mounted so that its weight is not supported by the connecting lines or by the inlet or outlet connections of the strainer or filter itself, unless adequate strength margins under all loading conditions are provided in the lines and connections; and

§ 23.1019 [Amended]

8. By removing the phrases "and the mesh" and "of the screen" from § 23.1019 (a)(2) and (a)(3), respectively.

9. By revising § 23.1021 to read as follows:

§ 23.1021 Oil system drains.

A drain [or drains] must be provided to allow safe drainage of the oil system. Each drain must—

(a) Be accessible; and

(b) Have manual or automatic means for positive locking in the closed position.

10. By revising § 23.1093(b)(2) to read as follows:

§ 23.1093 Induction system icing protection.

(b) * * *

(2) Each turbine engine must idle for 30 minutes on the ground, with the air bleed available for engine icing protection at its critical condition, without adverse effect, in an atmosphere that is at a temperature between 15° and 30°F (between -9° and -1°C) and has a liquid water content not less than 0.3 grams per cubic meter in the form of drops having a mean effective diameter

not less than 20 microns, followed by momentary operation at takeoff power or thrust. During the 30 minutes of idle operation, the engine may be run up periodically to a moderate power or thrust setting in a manner acceptable to the Administrator.

11. By amending § 23.1143 by redesignating present paragraph (e) as paragraph (f) and by adding a new paragraph (e) to read as follows:

§ 23.1143 Engine controls.

(e) For each fluid injection (other than fuel) system and its controls not provided and approved as part of the engine, the applicant must show that the flow of the injection fluid is adequately controlled.

12. By revising § 23.1163(a) to read as follows:

§ 23.1163 Powerplant accessories.

(a) Each engine mounted accessory must—

(1) Be approved for mounting on the engine involved;

(2) Use the provisions on the engine for mounting; and

(3) Be sealed to prevent contamination of the engine oil system and the accessory system.

13. By amending § 23.1183 by revising the title; by removing "20 quart" in paragraph (a) and inserting, in its place, "25-quart"; and by revising paragraph (b)(1) to read as follows:

§ 23.1183 Lines, fittings, and components.

(b) * * *

(1) Lines, fittings, and components which are already approved as part of a type certificated engine; and

14. By amending § 23.1189 by adding the phrase "or located in areas not subject to engine fire conditions" at the end of paragraph (b)(2) and by revising paragraph (a)(1) to read as follows:

§ 23.1189 Shutoff means.

(a) * * *

(1) Each engine installation must have means to shut off or otherwise prevent hazardous quantities of fuel, oil, deicing fluid, and other flammable liquids from flowing into, within, or through any engine compartment, except in lines, fittings, and components forming an integral part of an engine.

PART 25—AIRWORTHINESS STANDARDS: TRANSPORT CATEGORY AIRPLANES

15. By revising § 25.33(a)(2) to read as follows:

§ 25.33 Propeller speed and pitch limits.

(a) * * *

(2) Compliance with the performance requirements of §§ 25.101 through 25.125.

* * *

§ 25.697 [Amended]

16. By revising § 25.697(a) by removing the phrase "established under § 25.47." at the end of the first sentence and inserting, in its place, the phrase "established under § 25.101(d)."

17. By revising § 25.903(a) to read as follows:

§ 25.903 Engines.

(a) *Engine type certificate.*

(1) Each engine must have a type certificate.

(2) Each turbine engine must either—

(i) Comply with § 33.77 of this chapter in effect on October 31, 1974, or as subsequently amended; or

(ii) Be shown to have a foreign object ingestion service history in similar installation locations which has not resulted in any unsafe condition.

* * *

18. By revising § 25.905(a) to read as follows:

§ 25.905 Propellers.

(a) Each propeller must have a type certificate.

* * *

19. By revising § 25.961(a)(4)(i) to read as follows:

§ 25.961 Fuel system hot weather operation.

(a) * * *

(4) * * *

(i) For reciprocating engine powered airplanes, the maximum airspeed established for climbing from takeoff to the maximum operating altitude with the airplane in the following configuration:

(A) Landing gear retracted.

(B) Wing flaps in the most favorable position.

(C) Cowl flaps (or other means of controlling the engine cooling supply) in the position that provides adequate cooling in the hot-day condition.

(D) Engine operating within the maximum continuous power limitations.

(E) Maximum takeoff weight; and

* * *

20. By revising § 25.994 to read as follows:

§ 25.994 Fuel system components.

Fuel system components in an engine nacelle or in the fuselage must be protected from damage which could result in spillage of enough fuel to constitute a fire hazard as a result of a wheels-up landing on a paved runway.

21. By amending § 25.997 by removing the term "and the mesh" from paragraph (d) and by revising paragraph (c) to read as follows:

§ 25.997 Fuel strainer or filter.

* * *

(c) Be mounted so that its weight is not supported by the connecting lines or by the inlet or outlet connections of the strainer or filter itself, unless adequate strength margins under all loading conditions are provided in the lines and connections; and

* * *

22. By amending § 25.1001 by removing present paragraphs (a) through (g) and inserting in place thereof new paragraphs (a) through (d) as follows and by redesignating present paragraphs (h) through (l) as paragraphs (e) through (i):

§ 25.1001 Fuel jettisoning system.

(a) A fuel jettisoning system must be installed on each airplane unless it is shown that the airplane meets the climb requirements of § 25.119 and § 25.121(d) at maximum takeoff weight, less the actual or computed weight of fuel necessary for a 15-minute flight comprised of a takeoff, go-around, and landing at the airport of departure with the airplane configuration, speed, power, and thrust the same as that used in meeting the applicable takeoff, approach, and landing climb performance requirements of this part.

(b) If a fuel jettisoning system is required it must be capable of jettisoning enough fuel within 15 minutes, starting with the weight given in paragraph (a) of this section, to enable the airplane to meet the climb requirements of §§ 25.119 and 25.121(d), assuming that the fuel is jettisoned under the conditions, except weight, found least favorable during the flight tests prescribed in paragraph (c) of this section.

(c) Fuel jettisoning must be demonstrated beginning at maximum takeoff weight with flaps and landing gear up and in—

(1) A power-off glide at 1.4 Vs;
(2) A climb at the one-engine inoperative best rate-of-climb speed, with the critical engine inoperative and the remaining engines at maximum continuous power; and

(3) Level flight at 1.4 Vs; if the results of the tests in the conditions specified in paragraphs (c) (1) and (2) of this section show that this condition could be critical.

(d) During the flight tests prescribed in paragraph (c) of this section, it must be shown that—

(1) The fuel jettisoning system and its operation are free from fire hazard;

(2) The fuel discharges clear of any part of the airplane;

(3) Fuel or fumes do not enter any parts of the airplane; and

(4) The jettisoning operation does not adversely affect the controllability of the airplane.

* * *

§ 25.1013 [Amended]

23. By amending § 25.1013 by removing "20-quart" in paragraph (a) and inserting "25-quart" in its place.

§ 25.1019 [Amended]

24. By removing the phrases "and the mesh" and "of the screen" from §§ 25.1019 (a)(2) and (a)(3), respectively.

25. By revising the title and text of § 25.1021 to read as follows:

§ 25.1021 Oil system drains.

A drain [or drains] must be provided to allow safe drainage of the oil system. Each drain must—

(a) Be accessible; and

(b) Have manual or automatic means for positive locking in the closed position.

26. By amending § 25.1045(d) by removing the reference to § 25.67(d) and inserting § 25.121(c) in its place and by adding the following material to the end of paragraph (d):

§ 25.1045 Cooling test procedures.

(d) * * * The airplane must be in the following configuration:

(1) Landing gear retracted.

(2) Wing flaps in the most favorable position.

(3) Cowl flaps (or other means of controlling the engine cooling supply) in the position that provides adequate cooling in the hot-day condition.

(4) Critical engine inoperative and its propeller stopped.

(5) Remaining engines at the maximum continuous power available for the altitude.

* * *

27. By revising § 25.1091(e) to read as follows:

§ 25.1091 Air induction.

* * *

(e) If the engine induction system contains parts or components that could be damaged by foreign objects entering the air inlet, it must be shown by tests or, if appropriate, by analysis that the induction system design can withstand the foreign object ingestion test conditions of § 33.77 of this chapter without failure of parts or components that could create a hazard.

28. By revising the title of § 25.1093 and by revising paragraph (b)(2) to read as follows:

§ 25.1093 Induction system icing protection.

(b) * * *

(2) Each turbine engine must idle for 30 minutes on the ground, with the air bleed available for engine icing protection at its critical condition, without adverse effect, in an atmosphere that is at a temperature between 15° and 30°F (between -9° and -1°C) and has a liquid water content not less than 0.3 grams per cubic meter in the form of drops having a mean effective diameter not less than 20 microns, followed by momentary operation at takeoff power or thrust. During the 30 minutes of idle operation, the engine may be run up periodically to a moderate power or thrust setting in a manner acceptable to the Administrator.

29. By revising § 25.1143(d) to read as follows:

§ 25.1143 Engine controls.

(d) For each fluid injection (other than fuel) system and its controls not provided and approved as part of the engine, the applicant must show that the flow of the injection fluid is adequately controlled.

30. By revising § 25.1163(a) to read as follows:

§ 25.1163 Powerplant accessories.

(a) Each engine mounted accessory must—

(1) Be approved for mounting on the engine involved;

(2) Use the provisions on the engine for mounting; and

(3) Be sealed to prevent contamination of the engine oil system and the accessory system.

31. By amending § 25.1183 by removing "20 quart" in paragraph (a) and inserting "25-quart" in its place and by revising paragraph (b)(1) to read as follows:

§ 25.1183 Flammable fluid-carrying components.

(b) * * *

(1) Lines, fittings, and components which are already approved as part of a type certificated engine; and

32. By amending § 25.1189 by inserting the word "installation" after "engine" in paragraph (a) and by revising paragraphs (a) (1) and (2) to read as follows:

§ 25.1189 Shutoff means.

(a) * * *

(1) Lines, fittings, and components forming an integral part of an engine; and

(2) Oil systems for turbine engine installations in which all components of the system in a designated fire zone, including oil tanks, are fireproof or located in area not subject to engine fire conditions.

§ 25.1323 [Amended]

33. By removing the phrase "§ 25.59 or" from § 25.1323(b)(2).

§ 25.1359 [Amended]

34. By removing "§ 25.1205" in § 25.1359(a) and inserting "§ 25.867" in its place.

§ 25.1521 [Amended]

35. By removing the phrase "paragraphs (a) (1) through (3) of this section" in § 25.1521(b)(4) and inserting "paragraphs (b) (1) through (3) of this section" in its place.

PART 27—AIRWORTHINESS STANDARDS: NORMAL CATEGORY ROTORCRAFT

36. By revising § 27.903(a) to read as follows:

§ 27.903 Engines.

(a) *Engine type certification.* Each engine must have a type certificate.

37. By amending § 27.997 by removing the term "and the mesh" from paragraph (d) and by revising paragraph (c) to read as follows:

§ 27.997 Fuel strainer or filter.

(c) Be mounted so that its weight is not supported by the connecting lines or by the inlet or outlet connections of the strainer or filter itself, unless adequate strength margins under all loading conditions are provided in the lines and connections; and

§ 27.1019 [Amended]

38. By removing the phrases "and the mesh" and "of the screen" from § 27.1019 (a)(2) and (a)(3), respectively.

39. By revising § 27.1021 to read as follows:

§ 27.1021 Oil system drains.

A drain [or drains] must be provided to allow safe drainage of the oil system. Each drain must—

(a) Be accessible; and

(b) Have manual or automatic means for positive locking in the closed position.

40. By revising § 27.1093(b)(2) to read as follows:

§ 27.1093 Induction system icing protection.

(b) * * *

(2) Each turbine engine must idle for 30 minutes on the ground, with the air bleed available for engine icing protection at its critical condition, without adverse effect, in an atmosphere that is at a temperature between 15° and 30°F (between -9° and -1°C) and has a liquid water content not less than 0.3 gram per cubic meter in the form of drops having a mean effective diameter not less than 20 microns, followed by momentary operation at takeoff power or thrust. During the 30 minutes of idle operation, the engine may be run up periodically to a moderate power or thrust setting in a manner acceptable to the Administrator.

41. By revising § 27.1163(a) to read as follows:

§ 27.1163 Powerplant accessories.

(a) Each engine-mounted accessory must—

(1) Be approved for mounting on the engine involved;

(2) Use the provisions on the engine for mounting; and

(3) Be sealed in such a way as to prevent contamination of the engine oil system and the accessory system.

42. By amending § 27.1183 by revising the title; by removing "20 quart" in paragraph (a) and inserting "25-quart" in its place; and by revising paragraph (b)(1) to read as follows:

§ 27.1183 Lines, fittings, and components.

(b) * * *

(1) Lines, fittings, and components which are already approved as part of a type certificated engine; and

43. By amending § 27.1189 by redesignating (a)(2) as (a)(3) and by revising (a)(1) and adding a new (a)(2) to read as follows:

§ 27.1189 Shutoff means.

- (a) * * *
- (1) Lines, fittings, and components forming an integral part of an engine;
 - (2) For oil systems for which all components of the system, including oil tanks, are fireproof or located in areas not subject to engine fire conditions; and
- * * *

PART 29—AIRWORTHINESS STANDARDS: TRANSPORT CATEGORY ROTORCRAFT

44. By revising § 29.903(a) to read as follows:

§ 29.903 Engines.

(a) *Engine type certification.* Each engine must have a type certificate.

* * *

45. By amending § 29.997 by removing the term "and the mesh" from paragraph (d) and by revising paragraph (c) to read as follows:

§ 29.997 Fuel strainer or filter.

(c) Be mounted so that its weight is not supported by the connecting lines or by the inlet or outlet connections of the strainer or filter itself, unless adequate strength margins under all loading conditions are provided in the lines and connections; and

* * *

§ 29.1019 [Amended]

46. By removing the phrases "and the mesh" and "of the screen" from § 29.1019(a)(2) and (a)(3), respectively.

47. By revising § 29.1021 to read as follows:

§ 29.1021 Oil system drains.

A drain [or drains] must be provided to allow safe drainage of the oil system. Each drain must—

- (a) Be accessible; and
- (b) Have manual or automatic means for positive locking in the closed position.

48. By revising § 29.1093(b)(2) to read as follows:

§ 29.1093 Induction system icing protection.

- (b) * * *
- (2) Each turbine engine must idle for 30 minutes on the ground, with the air bleed available for engine icing protection at its critical condition, without adverse effect, in an atmosphere that is at a temperature between 15° and

30°F (between -9° and -1°C) and has a liquid water content not less than 0.3 grams per cubic meter in the form of drops having a mean effective diameter not less than 20 microns, followed by momentary operation at takeoff power or thrust. During the 30 minutes of idle operation, the engine may be run up periodically to a moderate power or thrust setting in a manner acceptable to the Administrator.

* * *

49. By revising § 29.1163(a) to read as follows:

§ 29.1163 Powerplant accessories.

(a) Each engine mounted accessory must—

- (1) Be approved for mounting on the engine involved;
 - (2) Use the provisions on the engine for mounting; and
 - (3) Be sealed in such a way as to prevent contamination of the engine oil system and the accessory system.
- * * *

50. By amending § 29.1183 by revising the title; by removing "20 quart" in paragraph (a) and inserting "25-quart" in its place; and by revising paragraph (b)(1) to read follows:

§ 29.1183 Lines, fittings, and components.

- (b) * * *
- (1) Lines, fittings, and components which are already approved as part of a type certificated engine; and
- * * *

51. By revising § 29.1189 (a)(1) and (a)(2) to read as follows:

§ 29.1189 Shutoff means.

- (a) * * *
- (1) For lines, fittings, and components forming an integral part of an engine;
 - (2) For oil systems for turbine engine installations in which all components of the system, including oil tanks, are fireproof or located in areas not subject to engine fire conditions; or
- * * *

PART 33—AIRWORTHINESS STANDARDS: AIRCRAFT ENGINES

52. By amending § 33.7 by removing paragraph (c)(17) and by revising paragraphs (c)(5)(i), (c)(5)(iv), (c)(6)(ii), and (c)(16) to read as following:

§ 33.7 Engine ratings and operating limitations.

- (c) * * *
- (5) * * *

(i) Oil at a location specified by the applicant;

* * *

(iv) Fuel at a location specified by the applicant; and

* * *

(6) * * *

(ii) Oil at a location specified by the applicant;

* * *

(16) For engines to be used in supersonic aircraft, engine rotor windmilling rotational r.p.m.

53. By revising § 33.14 to read as follows:

§ 33.14 Start-stop cyclic stress (low-cycle fatigue).

By a procedure approved by the FAA, operating limitations must be established which specify the maximum allowable number of start-stop stress cycles for each rotor structural part (such as discs, spacers, hubs, and shafts of the compressors and turbines), the failure of which could produce a hazard to the aircraft. A start-stop stress cycle consists of a flight cycle profile or an equivalent representation of engine usage. It includes starting the engine, accelerating to maximum rated power or thrust, decelerating, and stopping. For each cycle, the rotor structural parts must reach stabilized temperature during engine operation at a maximum rate power or thrust and after engine shutdown, unless it is shown that the parts undergo the same stress range without temperature stabilization.

54. By revising § 33.15(b) to read as follows:

§ 33.15 Materials.

(b) Conform to approved specifications (such as industry or military specifications) that ensure their having the strength and other properties assumed in the design data.

55. By amending § 33.17 by removing the term "20-quart" in paragraph (c) and inserting the term "25-quart" in its place; by removing paragraph (f); and by revising paragraph (a) to read as follows:

§ 33.17 Fire prevention.

(a) The design and construction of the engine and the materials used must minimize the probability of the occurrence and spread of fire. In addition, the design and construction of turbine engines must minimize the probability of the occurrence of an internal fire that could result in

structural failure, overheating, or other hazardous conditions.

§ 33.19 [Amended]

56. By amending § 33.19(a) by inserting after the last sentence a new sentence as follows: "Energy levels and trajectories of fragments resulting from rotor blade failure that lie outside the compressor and turbine rotor cases must be defined."

57. By revising § 33.23 to read as follows:

§ 33.23 Engine mounting attachments and structure.

(a) The maximum allowable limit and ultimate loads for engine mounting attachments and related engine structure must be specified.

(b) The engine mounting attachments and related engine structure must be able to withstand—

(1) The specified limit loads without permanent deformation; and

(2) The specified ultimate loads without failure, but may exhibit permanent deformation.

58. By revising § 33.25 to read as follows:

§ 33.25 Accessory attachments.

The engine must operate properly with the accessory drive and mounting attachments loaded. Each engine accessory drive and mounting attachment must include provisions for sealing to prevent contamination of, or unacceptable leakage from, the engine interior. A drive and mounting attachment requiring lubrication for external drive splines, or coupling by engine oil, must include provisions for sealing to prevent unacceptable loss of oil and to prevent contamination from sources outside the chamber enclosing the drive connection. The design of the engine must allow for the examination, adjustment, or removal of each accessory required for engine operation.

59. By revising § 33.27 to read as follows:

§ 33.27 Turbine, compressor, fan, and turbosupercharger rotors.

(a) Turbine, compressor, fan, and turbosupercharger rotors must have sufficient strength to withstand the test conditions specified in paragraph (c) of this section.

(b) The design and functioning of engine control devices, systems, and instruments must give reasonable assurance that those engine operating limitations that affect turbine, compressor, fan, and turbosupercharger rotor structural integrity will not be exceeded in service.

(c) The most critically stressed rotor component (except blades) of each turbine, compressor, and fan, including integral drum rotors and centrifugal compressors in an engine or turbosupercharger, as determined by analysis or other acceptable means, must be tested for a period of 5 minutes—

(1) At its maximum operating temperature, except as provided in paragraph (c)(2)(iv) of this section; and

(2) At the highest speed of the following, as applicable:

(i) 120 percent of its maximum permissible r.p.m. if tested on a rig and equipped with blades or blade weights.

(ii) 115 percent of its maximum permissible r.p.m. if tested on an engine.

(iii) 115 percent of its maximum permissible r.p.m. if tested on turbosupercharger driven by a hot gas supply from a special burner rig.

(iv) 120 percent of the r.p.m. at which, while cold spinning, it is subject to operating stresses that are equivalent to those induced at the maximum operating temperature and maximum permissible r.p.m.

(v) 105 percent of the highest speed that would result from failure of the most critical component or system in a representative installation of the engine.

(vi) The highest speed that would result from the failure of any component or system in a representative installation of the engine, in combination with any failure of a component or system that would not normally be detected during a routine preflight check or during normal flight operation.

Following the test, each rotor must be within approved dimensional limits for an overspeed condition and may not be cracked.

60. By adding a new § 33.35(e) to read as follows:

§ 33.35 Fuel and induction system.

(e) If provided as part of the engine, the applicant must show for each fluid injection (other than fuel) system and its controls that the flow of the injected fluid is adequately controlled.

61. By amending § 33.43 by removing the second sentence of paragraph (a) and by adding a new paragraph (d) to read as follows:

§ 33.43 Vibration test.

(d) The vibration survey described in paragraph (a) of this section must be repeated with that cylinder not firing which has the most adverse vibration effect, in order to establish the conditions under which the engine can

be operated safely in that abnormal state. However, for this vibration survey, the engine speed range need only extend from idle to the maximum desired takeoff speed, and compliance with paragraph (b) of this section need not be shown.

62. By revising § 33.49(e)(1)(ii) to read as follows:

§ 33.49 Endurance test.

(e) * * *

(1) * * *

(ii) The portions of the runs specified in Paragraphs (b) (2) through (7) of this section at rated maximum continuous power must be made at critical altitude pressure, and the portions of the runs at other power must be made at 8,000 feet altitude pressure; and

§ 33.63 [Amended]

63. By removing the word "normal" from § 33.63.

64. By revising § 33.66 to read as follows:

§ 33.66 Bleed air system.

The engine must supply bleed air without adverse effect on the engine, excluding reduced thrust or power output, at all conditions up to the discharge flow conditions established as a limitation under § 33.7(c)(11). If bleed air used for engine anti-icing can be controlled, provision must be made for a means to indicate the functioning of the engine ice protection system.

65. By amending § 33.67 by removing the last sentence of paragraph (a); by removing paragraph (b)(7); by revising paragraphs (b)(3), (b)(4), and (b)(5); and by adding a new paragraph (c) to read as follows:

§ 33.67 Fuel system.

(b) * * *

(3) It must be mounted so that its weight is not supported by the connecting lines or by the inlet or outlet connections of the strainer or filter, unless adequate strength margins under all loading conditions are provided in the lines and connections.

(4) It must have the type and degree of fuel filtering specified as necessary for protection of the engine fuel system against foreign particles in the fuel. The applicant must show:

(i) That foreign particles passing through the specified filtering means do not impair the engine fuel system functioning; and

(ii) That the fuel system is capable of sustained operation throughout its flow

and pressure range with the fuel initially saturated with water at 80°F (27°C) and having 0.025 fluid ounces per gallon (0.20 milliliters per liter) of free water added and cooled to the most critical condition for icing likely to be encountered in operation. However, this requirement may be met by demonstrating the effectiveness of specified approved fuel anti-icing additives, or that the fuel system incorporates a fuel heater which maintains the fuel temperature at the fuel strainer or fuel inlet above 32°F (0°C) under the most critical conditions.

(5) The applicant must demonstrate that the filtering means has the capacity (with respect to engine operating limitations) to ensure that the engine will continue to operate within approved limits, with fuel contaminated to the maximum degree of particle size and density likely to be encountered in service. Operation under these conditions must be demonstrated for a period acceptable to the Administrator, beginning when indication of impending filter blockage is first given by either:

- (i) Existing engine instrumentation; or
- (ii) Additional means incorporated into the engine fuel system.

(c) If provided as part of the engine, the applicant must show for each fluid injection (other than fuel) system and its controls that the flow of the injected fluid is adequately controlled.

66. By revising § 33.68(b) to read as follows:

§ 33.68 Induction system icing.

(b) Idle for 30 minutes on the ground, with the available air bleed for icing protection at its critical condition, without adverse effect, in an atmosphere that is at a temperature between 15° and 30°F (between -9° and -1°C) and has a liquid water content not less than 0.3 grams per cubic meter in the form of drops having a mean effective diameter not less than 20 microns, followed by a momentary operation at takeoff power or thrust. During the 30 minutes of idle operation the engine may be run up periodically to a moderate power or thrust setting in a manner acceptable to the Administrator.

67. By amending § 33.71 by removing the phrase "and the mesh" from paragraph (b)(3); by revising paragraph (b) introductory text; by revising

paragraphs (b)(4), (c)(5), (c)(11), and (d); and by adding a new paragraph (c)(12) to read as follows:

§ 33.71 Lubrication system.

(b) *Oil strainer or filter.* There must be an oil strainer or filter through which all of the engine oil flows. In addition:

(4) For each strainer or filter required by this paragraph, except the strainer or filter at the oil tank outlet, there must be means to indicate contamination before it reaches the capacity established in accordance with paragraph (b)(3) of this section.

(c) * * *

(5) Each oil tank filler must be marked with the word "oil."

(11) Each oil tank must have an oil quantity indicator or provisions for one.

(12) If the propeller feathering system depends on engine oil—

(i) There must be means to trap an amount of oil in the tank if the supply becomes depleted due to failure of any part of the lubricating system other than the tank itself;

(ii) The amount of trapped oil must be enough to accomplish the feathering operation and must be available only to the feathering pump; and

(iii) Provision must be made to prevent sludge or other foreign matter from affecting the safe operation of the propeller feathering system.

(d) *Oil drains.* A drain (or drains) must be provided to allow safe drainage of the oil system. Each drain must—

- (1) Be accessible; and
- (2) Have manual or automatic means for positive locking in the closed position.

68. By revising § 33.75 (b) and (c) to read as follows:

§ 33.75 Safety analysis.

(b) Burst (release hazardous fragments through the engine case);

(c) Generate loads greater than those ultimate loads specified in § 33.23(a); or

69. By revising § 33.77 to read as follows:

§ 33.77 Foreign object ingestion.

(a) Ingestion of a 4-pound bird, under the conditions prescribed in paragraph (e) of this section, may not cause the engine to—

- (1) Catch fire;
- (2) Burst (release hazardous fragments through the engine case);
- (3) Generate loads greater than those ultimate loads specified in § 33.23(a); or
- (4) Lose the capability of being shut down.

(b) Ingestion of 3-ounce birds or 1½-pound birds, under the conditions prescribed in paragraph (e) of this section, may not—

- (1) Cause more than a sustained 25 percent power or thrust loss;
- (2) Require the engine to be shut down within 5 minutes from the time of ingestion; or
- (3) Result in a potentially hazardous condition.

(c) Ingestion of water, ice, or hail, under the conditions prescribed in paragraph (e) of this section, may not cause a sustained power or thrust loss, or require the engine to be shut down. It must be demonstrated that the engine can accelerate and decelerate safely while inducting a mixture of at least 4 percent water by weight of engine airflow following stabilized operation at both flight idle and takeoff power settings with at least a 4 percent water-to-air ratio.

(d) For an engine that incorporates a protection device, compliance with this section need not be demonstrated with respect to foreign objects to be ingested under the conditions prescribed in paragraph (e) of this section if it is shown that—

(1) Such foreign objects are of a size that will not pass through the protective device;

(2) The protective device will withstand the impact of the foreign objects; and

(3) The foreign object, or objects, stopped by the protective device will not obstruct the flow of induction air into the engine with a resultant sustained reduction in power or thrust greater than those values required by paragraphs (b) and (c) of this section.

(e) Compliance with paragraphs (a), (b), and (c) of this section must be shown by engine test under the following ingestion conditions:

Foreign object	Test quantity	Speed of foreign object	Engine operation	Ingestion
Birds:				
3-ounce size.....	One for each 50 square inches of inlet area or fraction thereof up to a maximum of 16 birds. Three-ounce bird ingestion not required if a 1½-pound bird will pass the inlet guide vanes into the rotor blades.	Liftoff speed of typical aircraft.....	Takeoff.....	In rapid sequence to simulate a flock encounter and aimed at selected critical areas.

Foreign object	Test quantity	Speed of foreign object	Engine operation	Ingestion
1½-pound size.....	One for the first 300 square inches of inlet area, if it can enter the inlet, plus one for each additional 600 square inches of inlet area or fraction thereof up to a maximum of 8 birds.	Initial climb speed of typical aircraft.....	Takeoff.....	In rapid sequence to simulate a flock encounter and aimed at selected critical areas.
4-pound size.....	One, if it can enter the inlet.....	Maximum climb speed of typical aircraft if the engine has inlet guide vanes. Lift-off speed of typical aircraft, if the engine does not have inlet guide vanes. Sucked in.....	Maximum cruise..... Takeoff.....	Aimed at critical area. Aimed at critical area.
Ice.....	Maximum accumulation on a typical inlet cowl and engine face resulting from a 2-minute delay in actuating anti-icing system, or a slab of ice which is comparable in weight or thickness for that size engine.		Maximum cruise.....	To simulate a continuous maximum icing encounter at 25°F.
Hail (0.8 to 0.9 specific gravity).	For all engines: With inlet area of not more than 100 square inches: one 1-inch hailstone. With inlet area of more than 100 square inches: one 1-inch and one 2-inch hailstone for each 150 square inches of inlet area or fraction thereof. For supersonic engines (in addition): 3 hailstones each having a diameter equal to that in a straight line variation from 1 inch at 35,000 feet to ¼ inch at 60,000 feet using diameter corresponding to the lowest supersonic cruise altitude expected.	Rough air flight speed of typical aircraft..... Supersonic cruise velocity. Alternatively, use subsonic velocities with larger hailstones to give equivalent kinetic energy.	Maximum cruise at 15,000 feet altitude. Maximum cruise.....	In a volley to simulate a hailstone encounter. One-half the number of hailstones aimed at random area over the face of the inlet and the other half aimed at the critical face area. Aimed at critical engine face area.
Water.....	At least 4 percent of engine airflow by weight.....	Sucked in.....	Flight idle, acceleration, takeoff, deceleration.	For 3 minutes each at idle and takeoff, and during acceleration and deceleration in spray to simulate rain.

NOTE.—The term "inlet area" as used in this section means the engine inlet projected area at the front face of the engine. It includes the projected area of any spinner or bullet nose that is provided.

70. By revising § 33.83 (a) and (b) to read as follows:

§ 33.83 Vibration test.

(a) Each engine must undergo a vibration survey to establish the vibration characteristics of the rotor discs, rotor blades, rotor shafts, stator blades, and any other components that are subject to vibratory exciting forces which could induce failure at the maximum inlet distortion limit. The survey is to cover the range of rotor speeds and engine power or thrust, under steady state and transient conditions, from idling speed to 103 percent of the maximum permissible speed. The survey must be conducted using the same configuration of the loading device which is used for the endurance test, except that the Administrator may allow the use of a modified configuration if that loading device type is incompatible with the necessary vibration instrumentation.

(b) The vibration stresses (or strains) of rotor and stator components determined under paragraph (a) of this section must be less, by a margin acceptable to the Administrator, than the endurance limit of the material from which these parts are made, adjusted for the most severe operating conditions.

71. By amending § 33.87 by revising (a) introductory text; by revising paragraphs (a)(3), (a)(5), (a)(6), and (d)(2); and by adding a new paragraph (d)(3) to read as follows:

§ 33.87 Endurance test.

(a) *General.* Each engine must be subjected to an endurance test that includes a total of 150 hours of operation

and, depending upon the type and contemplated use of the engine, consists of one of the series of runs specified in paragraphs (b) through (e) of this section, as applicable. For engines tested under paragraph (b), (c), or (d) of this section, the prescribed 6-hour test sequence must be conducted 25 times to complete the required 150 hours of operation. The following test requirements apply:

(3) Except as provided in paragraph (a)(5) of this section, power or thrust, gas temperature, rotor shaft rotational speed, and, if limited, temperature of external surfaces of the engine must be at least 100 percent of the value associated with the particular engine operation being tested. More than one test may be run if all parameters cannot be held at the 100 percent level simultaneously.

(5) Maximum air bleed for engine and aircraft services must be used during at least one-fifth of the runs. However, for these runs, the power or thrust or the rotor shaft rotational speed may be less than 100 percent of the value associated with the particular operation being tested if the Administrator finds that the validity of the endurance test is not compromised.

(6) Each accessory drive and mounting attachment must be loaded. The load imposed by each accessory used only for aircraft service must be the limit load specified by the applicant for the engine drive and attachment point during rated maximum continuous power or thrust and higher output. The endurance test of any accessory drive

and mounting attachment under load may be accomplished on a separate rig if the validity of the test is confirmed by an approved analysis.

(d) * * *

(2) In each 6-hour test sequence specified in paragraph (c) of this section, 30 minutes must be run at rated 30-minute power except that the last 5 minutes of one rated 30-minute power test period must be run at 2½-minute power.

(3) The tests required in paragraphs (c)(3) through (c)(6) of this section.

72. By revising the title and text of § 33.88 to read as follows:

§ 33.88 Engine overtemperature test.

Each engine must be run for 5 minutes at maximum permissible r.p.m with the gas temperature at least 75°F (42°C) higher than the maximum operating limit. Following this run, the turbine assembly must be within serviceable limits.

73. By revising § 33.89(b) to read as follows:

§ 33.89 Operation test.

(b) The operation test must include all testing found necessary by the Administrator to demonstrate that the engine has safe operating characteristics throughout its specified operating envelope.

74. By revising the title and text of § 33.90 to read as follows:

§ 33.90 Initial maintenance inspection.

Each engine, except engines being type certificated through amendment of an existing type certificate or through supplemental type certification procedures, must undergo an approved test run that simulates the conditions in which the engine is expected to operate in service, including typical start-stop cycles, to establish when the initial maintenance inspection is required. The test run must be accomplished on an engine which substantially conforms to the final type design.

75. By amending § 33.92 by inserting an initial phrase at the beginning of (a) and by revising (a)(2) and (a)(3) to read as follows:

§ 33.92 Windmilling tests.

(a) For engines to be used in supersonic aircraft, * * *

(2) Bursting (releasing hazardous uncontained fragments); or

(3) Generating loads greater than those ultimate loads specified in § 33.23(a).

§ 33.93 [Amended]

76. By amending § 33.93(b) by removing the word "component" and inserting the word "part" in its place.

77. By adding a new § 33.94 to read as follows:

§ 33.94 Blade containment and rotor unbalance tests.

(a) Except as provided in paragraph (b) of this section, it must be demonstrated by engine tests that the engine is capable of containing damage without catching fire and without failure of its mounting attachments when operated for at least 15 seconds, unless the resulting engine damage induces a self shutdown, after each of the following events:

(1) Failure of the most critical compressor or fan blade while operating at maximum permissible r.p.m. The blade failure must occur at the outermost retention groove or, for integrally-bladed rotor discs, at least 80 percent of the blade must fail.

(2) Failure of the most critical turbine blade while operating at maximum permissible r.p.m. The blade failure must occur at the outermost retention groove or, for integrally-bladed rotor discs, at least 80 percent of the blade must fail. The most critical turbine blade must be determined by considering turbine blade weight and the strength of the adjacent turbine case at case temperatures and pressures associated with operation at maximum permissible r.p.m.

(b) Analysis based on rig testing, component testing, or service experience may be substitute for one of the engine

tests prescribed in paragraphs (a)(1) and (a)(2) of this section if—

- (1) That test, of the two prescribed, produces the least rotor unbalance; and
- (2) The analysis is shown to be equivalent to the test.

(Secs. 313(a), 601, and 603, Federal Aviation Act of 1958 (49 U.S.C. 1354(a), 1421, and 1423); and 49 U.S.C. 106(g) Revised, Pub. L. 97-449, January 12, 1983)

Note.—The FAA has determined that this amendment yields overall cost benefits by eliminating unnecessarily stringent design requirements and by simplifying and clarifying existing rules without reducing the level of safety of engine installations. The amendment simplifies a number of technical requirements and removes administrative burdens on regulated persons and the FAA through amendment of regulations from which exemptions have been granted. Therefore, it has been determined that this is not a major regulation under Executive Order 12291. In addition, the FAA has determined that this amendment is not significant under the Department of Transportation Regulatory Policies and Procedures (44 FR 11034; February 26, 1979). The evaluation prepared for this action is contained in the regulatory docket. A copy of it may be obtained by contacting the person identified under the caption "FOR FURTHER INFORMATION CONTACT."

Issued in Washington, D.C., on December 16, 1983.

Michael J. Fenello,
Acting Administrator.

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